SUGGESTIONS

REGARDING THE

MANAGEMENT OF THE FORESTS

INCLUDED IN THE

FOREST SCHOOL CIRCLE,

NORTH-WESTERN PROVINCES,

BY

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CONTENTS.

CHAPTER I.

INTRODUCTION.

Para.		Page.
1.	Board of Inspection	1
2.	Account of tour	*ib.*
3.	General organization	*ib.*

CHAPTER II.

LAMBATÁCH AND DEOTA FORESTS.

Lambatách.

4.	Area, boundaries, and sub-division	2
5.	Configuration, rock, and soil	3
6.	Growing stock	*ib.*
7.	Protection	4
8.	Management	*ib.*
9.	Ringing of Spruce and Silver fir	*ib.*
10.	Thinning out of *Pinus excelsa*	5
11.	Sowing of Deodar	*ib.*

Deota.

12.	Area, boundaries, and sub-division	6
13.	Configuration of the ground, rock, and soil	*ib.*
14.	Roads and paths	7
15.	Timber slide and buildings	*ib.*
16.	Establishment and survey	*ib.*
17.	Growing stock	8
18.	Protection	*ib.*
19.	Fellings	*ib.*
20.	Valuation of growing stock	9
21.	Annual yield	10
22.	Financial effect of reduced out turn	*ib.*
23.	Distribution of felling operations	12
24.	Disposal of Deodar wood which cannot be profitably exported—Iron making ...	*ib.*
25.	Valuation surveys	13
26	Detailed description of compartments	*ib.*
27.	Counting of annual rings	*ib.*
28.	Reducing factor	14
29.	Cultural operations	*ib.*
30.	Summary of work to be done in 1879-80	*ib.*

CHAPTER III.

JAUNSÁR BÁWAR.

31.	Rights of Government	15
32.	Division into two Ranges	*ib.*

Deoban Range.

33.	Working plan of 1875	*ib.*
34.	Demand for fuel and timber for Chakrata	*ib.*
35.	Supply of fuel and timber whence obtainable	*ib.*
36.	Annual yield of blocks closed against grazing	16
37.	Estimated quantity of mature wood at present available in—1st, Bodyar	*ib.*
38.	Ditto ditto 2nd, Konain, including a part of Siári ...	17
39.	Ditto ditto 3rd, Kanásar	*ib.*
40.	Ditto ditto 4th, Mohna	*ib.*

CHAPTER III—*continued.*

JAUNSÁR BÁWAR—*continued.*

Para.		*Page.*
41.	System of felling recommended for Mohna	17
42.	Estimated quantity of mature wood available in—5th, the Thona block	18
43.	Mátkángra	*ib.*
44.	Summary of mature wood available in blocks protected against grazing	*ib.*
45.	Proposal to close parts of Hajáwa and Bajamára against grazing	*ib.*
46.	The closing of additional areas must be considered	19
47.	Closing of Kanjátra, Asmári, Kophti, and parts of Durání and Missau	*ib.*
48.	Karámba	*ib.*
49.	Pandáwa	20
50.	Recapitulation of proposed arrangement for the supply of fuel	*ib.*
51.	Supply of Deodar timber	*ib.*
52.	Plan of cutting	*ib.*
53.	Coppicing of Kharsu and other trees	21
54.	Planting operations	*ib.*
55.	Planting in cantonments	*ib.*
56.	Work accomplished	22
57.	Planting in Bodyar	*ib.*
58.	Progress already made in planting and sowing the Bodyar block	*ib.*
59.	Planting and sowing operations to be carried out in Bodyar	23
60.	Sowing in Bajamára	24
61.	Sowing in Choli (part of Siári block)	*ib.*
62.	Sowing in Jádi	*ib.*
63.	Sowing and planting in Mohna	*ib.*
64.	Sowing in Dárna	*ib.*
65.	General remarks regarding planting and sowing	25
66.	Fencing in Durání block	*ib.*

Báwar Range.

67.	Chief work in the Range	*ib.*
68.	Chir Forests on the Tons	*ib.*
69.	Road from Saiah *vid* Sangoti and Tiuni to the Chir forests	26
70.	Forests at the head of the Dhárágád and the Riknagád	*ib.*
71.	General remarks on the work to be done in the Jaunsár Forest Division. Description of compartments	27
72.	Valuation surveys	*ib.*
73.	Matters to be studied in Deoban Range	*ib.*

CHAPTER IV.

DEHRA DÚN.

74.	Area	28
75.	Principal trees found in the Dehra Dún Division	*ib.*
76.	Fire protection	*ib.*
77.	System of fire lines	*ib.*
78.	Fire lines and roads to be named and compartments to be numbered	29
79.	Thinning and creeper cutting at Bulawála	*ib.*
80.	System of thinnings to be adopted in future	30
81.	Descriptive account of compartments	32
82.	Sample plots	*ib.*
83.	Plantations	*ib.*
84.	Communications	33
85.	Huts and wells	34
86.	Work done at Bulawála	*ib.*
87.	Requirements of the villagers in the Dún	*ib.*
88.	Grazing dues and grass	35
89.	Khair and Sissoo forests	36
90.	Future yield of the Dún Forests	37

CHAPTER V.

SAHÁRUNPUR.

Para.		Page
91.	Sub-division into two Ranges	38
92.	Western Range	*ib.*
93.	System of collecting revenue	*ib.*
94.	System of leasing the revenue on minor forest produce to contractors	*ib.*
95.	Leasing of the revenue on cart loads of fuel, bamboos, and charcoal	*ib.*
96.	Objects for the maintenance of the existing chaukis	39
97.	Eastern Range	*ib.*
98.	Lakarkot Sál forest	40
99.	Bamboo forest	*ib.*
100.	Plantations	*ib.*
101.	Majhára forest	41
102.	Grazing	*ib.*
103.	Principal work to be done in the Saháranpur division	*ib.*

APPENDICES.

A.—Description of compartments, Deota Forest i

B.—Memorandum on the enumeration of Deodar trees in the Deota forest v

C.—Abstract of the outturn of cuttings in Mohna Block vii

ERRATA.

Page 2. *For* "Timli Pass on the *west*", *read* "Timli Pass on the *east*."

Page 7, paragraph 15. *For* "*increasd* by Rs. 50,562", *read* "*increased* by Rs. 50,562."

Page 12, paragraph 23, fourth clause. *For* "the general character of this *block* is similar to that of Dopta", *read* "the general character of this *compartment* is similar to that *of the lower compartments* of Dopta."

Page 14, paragraph 30. *For* "*felling* operations", *read* "*timber* operations."

Page 17, paragraph 40. *For* 5,33,365, *read* 5,33,765; *for* 2,51,830, *read* 2,52,230.

Page 18, paragraph 42. *For* "*This* block", *read* "*The Thona* block."

Page 25, paragraph 66. *For* "decided to *form*", *read* "decided to *fence*."

Page 26, paragraph 70. *For* "Northern portion of *Lakua*", *read* "Northern portion of *Lakau*."

Page 28, paragraph 75, second clause. *For* "Haldir", *read* "Haldu."

Page 31, paragraph 80. *For* "g.—*Daura*", *read* g.—*Dhaura*.

Page 32, paragraph 82. *For* "*Excresences*", *read* "*Excrescences*."

Page 35, paragraph 87, fourth clause. *For* "near the *village*", *read* "near the *villages*."

Page 38, paragraph 92. *For* "*Eriophorum comorum*," *Read* "*Eriophorum comosum*."

Appendix A. page iii, seventh line from the bottom. *For* "*withd*", *read* "*width*."

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CHAPTER I.

INTRODUCTION.

Board of Inspection.

1. UNDER the orders of the Government of India, a Board was appointed for the periodical inspection of the forests attached to the Forest School. Dr. W. Schlich, Conservator of Forests in Bengal, and Mr. J. S. Gamble, Assistant to the Inspector General of Forests, were appointed Members of the Board, the Inspector General of Forests being President. Unfortunately, at the time fixed for the meeting of the Board, Dr. Schlich's state of health precluded his being deputed for this duty, and Mr. J. S. Gamble was prevented by urgent work, which could not be postponed, from joining in the inspection. The duty of inspecting and reporting upon these forests on the present occasion, therefore, devolved upon the writer of this report.

Account of tour.

2. I left Simla on Monday, the 28th October, and having been joined by Captain Bailey, the Conservator of the School Forests and Superintendent of Forest Surveys, near Chepál on the 30th, I first devoted some time to the inspection of certain Deodar forests in the States of Jubal and Taroch, a detailed examination of which has been undertaken by the Superintendent of Forest Surveys at the request of the Punjab Government. From the 6th to the 11th November I examined Lambatách and Deota, two forests on the Tons river, leased from the Rajah of Tiri-Garhwál, and which are included within the Forest School Circle. The days from the 12th to the 19th were devoted to the forests in Jaunsár, and the time from the 20th to the 30th November was spent in the Dehra Dún and Saháranpur districts; Nágsidh, Lachiwála, Bulawála, and the forests on both sides of the Mohan Pass road, between the Bulawála and Khajnaor passes, both outside and inside the Siwáliks, being visited.

General organization.

3. Under the orders of the Government of India, the forests attached to the Forest School comprise the forests in the Saháranpur and Dehra Dún districts, including those of Jaunsár-Báwar, together with those forests leased from the Native State of Tiri-Garhwál which are situated on the Tons and

Jumna rivers, as well as a small portion of the forests leased from the Bashahr State. The area of these forests at the time of the present inspection will be apparent from the following statement:—

Forest Division.	Area.	Officer in charge.
1. Dehra Dún	171,982 acres	Mr. I. E. O'Callaghan, Deputy Conservator of Forests.
2. Saháranpur	175,366 „	Major Jarrett, Deputy Conservator of Forests.
3. Jaunsár	103,426 „	Mr. C Bagshawe, Deputy Conservator of Forests.

Two of the ranges of the Jaunsár Division are in charge of officers of the superior staff, *viz.*, the Deota range in charge of Mr. L. A. W. Rind, and the Deoban range in charge of Mr. A. Smythies, both Assistant Conservators.

Besides the Conservator, the several officers named accompanied me through their respective charges. In the present report no proposals will be submitted regarding the distribution of the superior and subordinate staff, and no remarks will be made regarding the financial results and financial prospects of the management of these forests. It will suffice to state that for the present it will probably be best to adopt the following general organization:—

DEHRA DÚN DIVISION.

1*st.*—Jumna Range, extending to the Timli Pass on the west, and including Ambári, Dholkot, and Chándpur.

2*nd.*—Central Range, including the forests on both sides of the Mohan Pass road.

3*rd.*—Bulawála Range, including Nágsidh, Lachiwála, Tháno, and the small blocks of Kachar, Saura-Saroli and Song.

4*th.*—Ganges Range, comprising the Dehra Dún Forests near the Ganges river.

SAHÁRANPUR DIVISION.

1*st.*—Eastern Range.

2*nd.*—Western Range.

JAUNSÁR DIVISION.

1*st.*—Deoban Range.

2*nd.*—Báwar Range.

3*rd.*—Deota Range.

The suggestions contained in the present report will be most conveniently arranged in the order in which the forests were visited.

CHAPTER II.

LAMBATÁCH AND DEOTA FORESTS.

Lambatách.

Area, boundaries and sub-divisions.

4. This, like the Deota Forest, is situated in Native Garhwál, and is held on lease from the Rajah of Tiri. The total area of Lambatách according to the recent survey is 2,963 acres. The outer boundary, which runs from Lambatách

peak round to Kimári village, is defined by a two-foot path. Within this boundary no grazing is allowed without special permission. Outside and near it, above Thanwár village, is an outer fire-line enclosing an area protected from fire, but not from grazing. In the other part of the forest the path defining the outer boundary coincides with the fire-line. Near Thanwár village the boundary-line is as yet in many places irregular, owing to the exclusion of fields, and this must be gradually amended. Within the outer forest boundary a right to cultivate certain fields near the Durrington hut has been maintained to the villagers of Butárn, but no other cultivation is included within the forest area. The eastern boundary is formed by the Lambatách ridge, which separates the Lambatách and Deota Forests. A survey on the scale of 4 inches = 1 mile was made in 1876-77, but the map has not yet been printed.

The forest has been divided into ten blocks, separated by natural features and permanent paths. The forester in charge is assisted by two forest guards, one of whom has charge of the northern and the other of the southern beat; and it is found convenient for them both to reside at Durrington. Besides the boundary-path, a number of two-foot paths have been made through the forest, and a branch of the Tons road runs from Maindrot to Durrington. The highest point is Lambatách peak, which has an elevation of 10,469 feet; the lowest block, Kandar, is about 6,800 feet above sea-level.

Configuration, rock and soil.

5. Lambatách may be generally described as consisting of one large bay, which occupies the centre of the forest, and is bounded on the north by the Ghoria and Jogi Ridge, and on the south by the Chákora and Samoni Ridge; and of three smaller bays, *viz.*, Thanwár on the north, and Lohásu and Inádi on the south. The central bay is drained by numerous feeders, which join and form the Butárn Gád. As a rule, the slopes on the right bank have a southerly and those on the left bank a northerly aspect; and a similar variety in the aspect of the slopes is observable in the smaller bays. Throughout the forest, rocky precipices and steep slopes alternate in a very irregular manner with slopes of a more easy gradient. The rock is principally shale and clay slate, but gneiss is found on the Lambatách peak. The soil is rich, and in many parts consists of a deep loam, with an abundance of vegetable-mould in the valleys and ravines and on the better-stocked slopes.

Growing stock.

6. Along the Lambatách ridge there is a narrow belt of Kharsu oak *(Quercus semicarpifolia)* which is of greatest width and nearly pure below the Lambatách peak. Lower down along the ridge it gradually narrows and becomes mixed with Silver fir *(Abies Webbiana)* and Deodar. Below this belt of Kharsu, and extending downwards along the valleys and ravines, the forest is Deodar mixed with Spruce (*Abies Smithiana*) and Silver fir, and a few Blue pines (*Pinus excelsa*). In Thanwár and the lower part of the Lohásu block the forest consists of Blue pine either nearly pure or mixed with Deodar. The Grey oak (*Quercus incana*) and the Moru oak (*Quercus dilatata*) are chiefly found in the Garásna block. Chir (*Pinus longifolia*) is found in the lower part of the Garásna and Dhámti blocks. There are large extents of grassy slopes without forest all along the outer boundary, particularly on the southern face of the Jogidhár, and there are similar slopes in the upper parts of the forest, the only block in which there are no blanks being Bunárpáni.

Excluding the slopes covered with grass or shrubs, and the belt in which the Kharsu oak prevails, the area of forest containing Deodar may be estimated at 1,800 acres. Pure Deodar forest is found in the upper parts of the Dhámti, Ghoria, Lohásu, Inádi and Kandár blocks; elsewhere this tree is mixed with Spruce in the centre of the forest, and with Blue pine in Thanwár in the lower part of Lohásu, and in that part of the Chákora block which adjoins Lohásu. In the upper part of Bunárpáni the forest consists of Silver and Spruce fir associated with a few Deodars. On the lower part of the Lambatách ridge, Deodar is mixed with the Kharsu oak. The undergrowth consists of Ringál, *Indigofera*, and *Desmodium*, and is most dense on damp northerly slopes, where it is mixed with Balsams and other large herbs.

Protection.

7. The forest has been protected against fire since the rains of 1869, and sheep and goats have been excluded since 1871. The western portion of the Dhámti block, above the village of that name, has been frequently burnt, and has only been regularly included in the reserved area since 1876. A destructive fire ran through the whole of Inádi in 1871; and about 30 acres of the same block in the portion adjoining Lohásu was burnt during the autumn of 1878. Grazing for the sheep of Pingál Patti and Kotigárh is allowed on the main ridge during the rains, and a right-of-way to and from this grazing-ground is allowed on the Nonidhár. The fear of fire is the chief reason why grazing is not allowed in the entire forest during autumn; while the seedlings would be eaten were it allowed in spring.

Protection from fire is effected by fire lines being burnt about November on the outside of the forest; and during the winter and spring the grass outside these fire-lines is also burnt. In case fires arise within the reserve, the system of paths facilitates protection; but it will be necessary to clear and burn fire-lines down some of the chief ridges, such as the Jogi, Noni, Samoni and Chákora dhárs.

Management.

8. Fellings commenced in 1870, and the last of the timber was exported in 1875. The total number of trees felled in all blocks was about 3,600. The fellings were evenly distributed throughout all the blocks, and they amounted to about two trees per acre on the Deodar-producing area. No further cuttings are recommended at present, and the only operations proposed for the forest are those intended to promote the growth of young Deodar. Protection against fire and grazing will doubtless effect a great deal in this direction, but protection will not do everything.

In considering the cultural operations which have been, or are to be, undertaken, it is well to note the three descriptions of forests to which they apply, *viz.*:—

(*a*)—areas in which Deodar is mixed with Spruce (*Abies Smithiana*) and Silver fir (*Abies Webbiana*);

(*b*)—areas where we find Deodar associated with the Blue pine (*Pinus excelsa*);

(*c*)—grassy slopes and blanks covered with *Indigofera heterantha*.

Ringing of Spruce and Silver fir.

9. A very important operation is that of killing Spruce and Silver fir by ringing (or peeling off the bark). This was begun in 1874, and has since then been continued steadily every year. The ringed trees generally die within a year, the Silver fir dying sooner than the Spruce. In the ravines above Durrington, through which the Garásna stream runs, in the Bunárpáni, and in other ravines, the appearance of the forest has been completely changed by this operation; the ground here, which was formerly covered with a dense forest of Spruce and Silver fir, being now open and ready for the springing up of young Deodar. Unfortunately in these places, on the rich and moist soil, the first result of the light thus given has been a luxuriant growth of Ringál, shrubs and herbs, which for the present at least puts any considerable growth of young Deodar out of the question. We have considered whether it would be advisable to make clearances in this luxuriant growth of shrubs and herbs, in order to encourage the growth of Deodar, but I have come to the conclusion that it will be better to defer this operation, as there are others which appear to be of more importance. In these moist places with deep and rich soil the growth of shrubs and herbs is so rapid that any clearances will be over-grown as soon as made. Sowing of Deodar, therefore, will not do much good, but eventually these localities may be stocked by the use of strong two or three-year-old nursery plants.

The ringing of Spruce and Silver fir, however, should be steadily continued where these trees are associated with Deodar, as was the case in the ravines already worked over. A question has been raised as to the mode in which the ringing should be effected. It has been done in Lambatách by peeling off the bark for a height of two feet all round the tree, while at Deota, by way of experiment, a cut has been made about 2 inches deep and 6 inches high through the bark and wood. The results of the two methods should be watched and

reported on. It is well known that cutting through the outer layer of the wood of trees like the two species named, which have no heart-wood, does not kill them as quickly as it does trees with a heart-wood similar to that of the Teak tree, and that it will be more effective and more economical to take off a broad strip of bark; but this can only be determined by experience. The objection to the ringing of Spruce and Silver fir on a large scale is, that if fires should unfortunately enter the forest, these dry trees and the branches that have fallen from them would enormously increase the injuries inflicted by fire; but in this respect nothing can be done but to use every effort to prevent the entry of fire into these forests.

The insects, which are undoubtedly generated when trees are killed on a large scale in this manner, have not yet been found to do any damage in this forest; but caution in this respect is necessary; and although it is recommended to proceed steadily with this operation, it will be necessary to watch the results very carefully, and only to take small areas in hand. It must be distinctly understood that no trees should be ringed in localities where there is no Deodar, or where only isolated trees of that species are found, nor should the operation extend to the top of ridges or to other places where it may appear desirable to maintain the ground well stocked with forest.

Thinning out of *Pinus excelsa*.

10. In those portions of this forest where Deodar is associated with the Blue pine and on many of the blank grassy slopes, an abundant growth of the Blue pine has sprung up since the forest was protected from cattle and fires. The seed of this pine is light, and has a large wing, and is therefore carried by the wind to great distances; moreover, the Blue pine requires no shelter, and springs up readily on open blank spaces. In Thanwár, Lohású and Chákora blocks there are extensive thickets of Blue pine saplings up to five feet high, mixed here and there with a stray Deodar. In the same blocks a certain quantity of younger growth of Blue pine and Deodar is also noticed; and although the Deodar, after it has attained a certain size, holds its own when associated with the Blue pine, yet while both are young there is much risk of the Deodar being choked by the Pine. In many places I noticed terminal shoots of the Pine two to three feet long and even longer. This tree is of a much more rapid and robust growth than the Deodar at this time of its life; moreover, in a thicket of young Pine, there is no chance of fresh Deodar seedlings springing up. It is obvious that in such places, if the young growth now on the ground is not interfered with, the result must be a forest consisting of Blue pine, and the wood of this tree, though more valuable than Spruce and Silver fir, does not fetch a sufficient price to render it desirable to raise forests of it in this locality. Fortunately, a small varying proportion of Deodar is generally associated with the Blue pine in these thickets. The development of this Deodar and the springing up of additional seedlings must be promoted. This can only be effected by the thinning out of the thickets of Blue pine. This is one of the most important cultural operations to be undertaken at Lambatách; and I have recommended that wherever thickets of young Blue pine are found, they must be cut down. It is not sufficient to lop the plants; they must be cut down close to the root. Where young Blue pines grow scattered in limited numbers mixed with Deodar, it will not be necessary to touch them; they tend to keep the ground moist, and to afford some shelter to the Deodar. This operation may be carried on through the forest as circumstances permit, but discretion should be used on precipitous ground and sharp exposed ridges. Here it will be well not to interfere with the existing growth, and where Deodar is scattered among thickets of the Blue pine it will be well to have some of the latter to act as nurses to the former.

Sowing of Deodar.

11. On slopes covered with grass and *Indigofera heterantha*, it will be desirable to commence sowing and planting Deodar as soon as competent and permanent supervision can be secured. I recommend that some of the slopes with a north-westerly aspect near Durrington be first taken in hand; these slopes contain thickets of Blue pine, but no Deodar, and I suggest that horizontal lines 20 feet apart be operated on. These lines should be staked out, and along them patches should be dug up, the sods of grass being thrown up below the lower edge of each patch. The distance between the lines should be

strictly maintained, but no hard-and-fast rule can be laid down regarding the distance between the patches; this must be regulated entirely by the nature of the ground. The patches should be sown in autumn or early spring. This arrangement of lines far apart has the advantage of diminishing expense, facilitating control, and of making it easy to fill up blanks caused by failures in the lines.

Where there is Deodar or other forest growth on the ground, it will suffice to have these lines 30 feet apart, or at even greater distances. After sufficient experience has been acquired in sowing on this principle, and the operation has been reduced to a regular routine, an attempt should be made to fill up the grassy slopes in the Dhámti block, and the higher part of the forest near the Lambatách ridge; but the operation must be commenced in the vicinity of Durrington, where circumstances are most favourable, where success is most likely to be attained, and where arrangements can be made for its continuous supervision.

Deota.

Area, boundaries, and sub-division.

12. The total area of this forest is 5,087 acres according to the recent survey. This area does not include the Bámsu forest, area 2,101 acres, of which nothing will be said in this report, but that it has been protected from fire since 1874, and consists of a mixed forest of Deodar, Spruce, Silver fir, and Blue pine, with Kharsu on the higher ground. This and the Surars forest should be opened out by inspection paths, and a preliminary examination of the contents of these forests should be made. The outer boundary of the Deota Forest, which runs from Kimári village to the Deota ridge, is defined by a two foot path. Within this boundary, no grazing is allowed without special permission; but some cultivated fields above Kimári village are at present included within the boundary. The boundary as it at present stands may be considered a satisfactory one. The forest has been divided into ten blocks, bounded by natural features and permanent paths.

The upper part of Deota may be regarded as consisting of four bays—

1*st*.—that including the Kimári block between the Kimári and Patángni dhárs, and drained by the Chabai gád;

2*nd*.—Patángni, between the Patángni and Kánga dhárs, drained by the Kánga gád.

3*rd*.—Kánga and Jaurási, between the ridges so named, and drained by the Misin gád;

4*th*.—the Temple Bay, round the head-waters of the Bagiár stream, and consisting of the remaining area between the Jaurási and Pálú dhárs, and comprising the Kata Tách, Dopta, Temple and Parthil Blocks.

Outside and below these four large bays are the blocks stocked with Chir called Bagiár and Thadiár, and situated on the right and left banks of the Bagiár stream; these are not included in the following description. At their lower ends, the four bays are rocky and precipitous, and are narrowed here into steep rocky gorges and ravines. This precipitous ground separates the Deota Forest into two clearly-defined portions, the lower and the upper. Deodar is the chief tree in the upper, and Chir (*Pinus longifolia*) in the lower portion. Slopes with an easy gradient below 30° are chiefly found in the centre part of the Parthil and Temple blocks. On the west bank of the Bagiár nadi, there are only small areas with easy slopes, the largest in extent being found in the lower part of Patángni and Kimári. The aspect varies extremely, for each block is divided by ravines and gullies, the opposite sides of which have different aspects.

Configuration of the ground, rock and soil.

13. The highest points in the forest are Lambatách Peak 10,469 feet, and Rikshins 10,314 feet. The lowest point, the mouth of the Bagiár nadi at its junction with the Tons, is about 3,400 feet.

The rock is chiefly gneiss, the soil throughout being a light sandy loam, with an abundance of black vegetable-mould in most places.

14. A branch of the Tons road six to eight feet wide has been made from Thadiár on the Tons, to Katkat, Parthil godown, and Jaurási dhár. The eastern half of the forest, including the Parthil, Temple, and Dopta blocks, has been opened out by a system of two-foot paths, and similar paths on the western or Kimári side are in course of construction. Roads and paths

15. A timber-slide about 13,000 feet in length has been constructed in the valley of the Bagiár. The head of the slide is at "Gúgi," and it runs into the Tons river at Thadiár, where the Bagiár nadi joins that river. The head of the slide is about 5,200 feet, and the lower end of it is about 3,400 feet above the sea. The slide is constructed in the form of an open trough, of which the bottom and sides are composed of thick Chir planks, 12 feet long and 15 × 4 inches in section. The trough rests upon and is let into short blocks of wood, and is secured firmly by means of wooden wedges. The short blocks, or "block sleepers," are laid on the rock, or on walling or trestles according to the configuration of the ground. The gradients vary from 1 in 2¼ to 1 in 20. The sleepers are sent down the slide by the aid of running-water, and about 1,800 sleepers a day go down when the water-supply is full. During the floating season the sleepers are shot straight into the Tons; at other times, the line of slide is diverted and raised so that the sleepers can be caught and stacked on the banks of the Tons ready for future launching. Including a small quantity of sleepers which still remains in the forest, the amount of timber which has been sent down the slide (all in the form of sleepers) amounts to about 520,000 cubic feet. The use of the slide saves about three miles carriage on men's backs. Buildings for the accommodation of Forest servants, and for the storage of food, have been erected at Katkat and Thadiár, as well as forest rest-houses for the officer in charge at the same places. A wire suspension-bridge with a span of 146 feet has been thrown over the Tons at Thadiár. The works previously noted were begun in 1876, and cost some forty thousand rupees, the details approximately being— Timber-slide and buildings.

		Rs.
Slide	... ...	26,000
Roads	... ..	7,800
Bridge	... ...	2,500
Buildings	... ...	3,700
	Total Rs.	40,000

Had the slide not been constructed, the charges for land-carriage on account of the timber already sent down it (*i.e.*, during the last three years) would have been increasd by Rs. 50,562. The slide may reasonably be expected to last for ten years; and, in order to compare what the cost of moving the timber has actually been with what it would have been without the slide, 10 per cent. per annum of the original outlay may be debited against the timber-works.

The cost of repairs during the first three years has been light, aggregating, with the cost of passing the timber down the slide, Rs. 2,335.

In constructing this slide the officers in charge of the work have been guided by the experience gained in the construction and working of the older slides by which the timber from the Mundhol and Lambatách forests was exported. The Deota slide has been admirably planned and economically constructed, and it has worked well from the commencement, without any hitch or difficulty. The work is most creditable to Mr. Bagshawe and Mr. Rind who executed it, and to the Conservator, Mr. G. Greig, under whose control it was built.

16. The present establishment in the Deota forest (which also attends to the timber-works) costs about Rs. 150 per mensem. Two forest guards, who live at Katkat, are specially responsible for the protection of the forest. A survey on the scale of 4 inches to 1 mile was begun in 1876-77, and has been completed, but the map is not yet published. Establishment and survey.

Growing stock.

17. Below Lambatách and Dopta ridges there is a belt, chiefly stocked with Kharsu, stunted Deodar and a little Silver fir, Kharsu being the prevailing tree. This description of forest growth covers a considerable area in Dopta, Jaurási, and Kánga. The ground below the Kharsu belt and above the line of precipices is chiefly stocked with Deodar, which is associated with Spruce and Silver fir on the more gentle slopes of the Parthil and Temple blocks, and on the slopes with a northerly aspect in Kánga, Patángni, and Jaurási. Of Deodar in general it may be noted that the different age-classes are well represented. In most places seedlings, saplings and poles are found wherever there are blanks in the mature crop. Blank slopes, without any forest growth in the Deodar portion, are only found in the vicinity of the Deota ridge, in the lower part of the Parthil block, and on precipitous slopes with a southern aspect in the Jaurási and Patángni blocks. The total area of Deodar-producing forest is about one-half of the whole area, or 2,500 acres. Moru oak (*Quercus dilatata*) is an important associate of Deodar over a considerable portion of the forest, and it is most common on gentle slopes with deep soil. On the west side of the Bagiár nadi there are three compartments having northerly and north-easterly aspects with a large proportion of Moru oak. Morú is also abundant east of the Bagiár, in the lower parts of the Temple, and the centre and upper parts of the Parthil, blocks. Chir forms the forest in the lower parts of all the blocks, up to the upper edge of the line of precipices; and the entire stock in Bagiár and Thadiár blocks is composed of this tree. Taking Deota Forest as a whole, the following forest zones may be distinguished:—

1*st*.—The zone of Chir extending up to 7,000 feet. In the upper part of this zone the Chir is mixed with Grey oak, Rhododendron (*R. arboreum*), and Aiyár (*Andromeda ovalifolia*), especially below Kimári village.

2*nd*.—The Moru oak zone, in which this tree is associated with Deodar and Spruce.

3*rd*.—The zone of Deodar, pure or mixed with Spruce and Silver fir.

4*th*.—The zone in which Kharsu oak is the chief tree.

A few walnut and chestnut trees are found associated with Deodar, and the Mountain birch (*Betula acuminata*) is not uncommon. Of the undergrowth little need be said. Ringál is found where the soil is deep and moist, and *Indigofera* and *Desmodium* are found on most blanks.

Protection.

18. Regular protection from fire and grazing began in 1874, but about half of the Thadiár (Chir) block was burnt in the winter of 1877. The villagers of Pingál Patti and Kotighár graze their cattle during the rains on the upper portions of the Lambatách, Dopta, and Deota ridges; but do not come into the Deodar forest. A fire-line is burnt annually along the outer boundary-path; interior fire-lines are also burnt on the Deota ridge and between the Chir and Deodar forest. Additional interior fire-lines are now being cut.

Fellings.

19. Fellings began in March 1876, and up to date 3,897 dry standing and fallen trees and 2,067 green trees have been sawn up: total 5,964 trees. All green trees felled were over six feet in girth. The fellings were limited to the Parthil and Temple Blocks. It is obvious that after a capital expenditure of Rs. 40,000 on the slide, roads and buildings, it is desirable to utilize these works by continuing the export of timber. Although complete data are not available to enable us to fix the annual yield of this forest if managed on rational principles, the data available will make it possible to frame an approximate estimate of the annual outturn during the next few years. It seems to me essential that for the next few years the annual outturn should be fixed, and that any great fluctuations should be avoided. The timber cut since 1876 has been exported in the form of broad

and metre-gauge sleepers. The quantity exported and now in course of exportation is—

Scantling.	No.	Cubic contents in feet.
15′ × 10″ × 5″	520 =	2,703
10′ × 10″ × 5″	135,000 =	472,500
6′ × 8″ × 4½″	35,000 =	46,600
Total cubic feet	...	521,803

Taking this quantity as the outturn of the years 1876 to 1878, it gives an annual outturn during the last three years of 170,000 cubic feet per annum.

20. In order to obtain data to determine the extent of future fellings, a valuation of the growing stock has been undertaken by Mr. Rind, the officer in charge of the range, under instructions received from Mr. Greig, the Conservator. A memorandum detailing the plan followed is appended to the present report. Valuation of growing stock.

For the purpose of this valuation survey the forest has been divided into forty compartments, bounded as a rule by natural features, but in a few cases by paths and artificial lines. The enumeration has been nearly completed in six out of ten blocks, but the whole of the work has not yet been checked, and it is not therefore advisable to consider the figures obtained in detail. The following general results may, however, be accepted as representing approximately the growing stock of Deodar:—

Number of block	Name of block.	Number of Deodar trees 6 feet and upwards in girth.	Number of Deodar trees 3 feet to 6 feet in girth.	Remarks.
1	Thadiár	*Nil.*	*Nil.*	
2	Parthil	3,522	3,263	After felling.
3	Temple	2,763	3,709	Ditto.
4	Dopta	2,921	5,324	No fellings made in these blocks.
5	Katatách	2,965	4,914	
6	Jaurási	5,505	6,424	
7	Kánga	3,220	3,686	
8	Patángni	5,000	5,000	Estimated.
9	Kimári	1,500	1,500	Ditto.
10	Bagiár	*Nil.*	*Nil.*	
	Total ...	27,396	33,820	

As before said, these figures are open to correction. In the absence of more reliable data, however, they must be accepted for the present. Assuming them to give an approximate statement of the growing stock, it is clear that if a uniform annual yield is aimed at, it will not be possible to continue cuttings at the same rate as they have been made during the last three years. Regarding the rate of growth, rings of annual growth have been counted on stumps of 252 trees in the Parthil and Temple Blocks.

This counting of rings, like the enumeration of the standing trees, was done by subordinates, and had not at the time of my visit been checked. It is doubtful whether anything is gained by entrusting observations of a scientific character to subordinates. However, we are not likely to be far wrong if we assume that in most portions of this forest, under ordinary circumstances, a tree three feet in girth will require 48 years to attain a girth of six feet.

Annual yield.

21. Of the 27,000 first class trees estimated to stand in this forest, fully one-third stand on precipitous ground and steep slopes, which at present it will be advisable to exclude entirely from the contemplated fellings. On the other hand, many trees below six feet in girth are not younger than the larger trees, and will never attain a girth of six feet. More cannot be done at present than to fix arbitrarily the maximum number of trees that may be cut annually until the matter can again be considered, and until its consideration can be based upon more reliable data than we at present possess. Under these circumstances, it has been decided to cut 750 trees annually for the present; the trees to be cut as a rule to be not less than six feet in girth, but under certain circumstances this girth to be reduced to five feet. Assuming that 18,000 trees are available in the forest at present, cuttings may at this rate be continued during 24 years, and before the expiration of this period matters can be further considered.

This quantity is more than the Deota Forest is likely to yield permanently, but it would hardly be worthwhile maintaining timber operations if a smaller annual yield were fixed. It does not, however, follow that an annual yield of 750 trees during the next 24 years is to be rigidly maintained. It may be found more convenient to cut out the mature timber during the next 12 years at the rate of 1,500 trees per annum, but before this can be attempted, the reproduction of Deodar in the blocks already felled must be carefully watched during a series of years, in order to determine to what extent Deodar may be cut out from these forests, and in what manner these fellings should be arranged. At the outset it will be safe to limit fellings to the number mentioned, *viz.*, 750 trees annually.

In most blocks of the forest, each tree cut may be expected to yield an average outturn of twenty broad-gauge sleepers, giving a total outturn of 15,000 sleepers, or 52,500 cubic feet a year.

Financial effect of reduced outturn.

22. This is less than one-third of the outturn of the last three years; and the first question to be considered is whether it is consistent with financial considerations so considerably to reduce the outturn of timber; in other words, whether the general charges with which the timber from this forest must be debited will not raise the cost per cubic foot of so small an outturn to a prohibitory rate.

I have considered whether arrangements could not be made to export the timber of this forest in some other shape than railway sleepers. The export of round logs is not at present practicable owing to the difficult nature of the ground; but it is not impossible that at a distant date roads and timber slides may be constructed, and the timber moved in a manner similar to that pursued in the Black Forest and the Bavarian Alps. This, however, requires two conditions which are at present wanting, *viz.* :—

1*st.*—A body of labourers born and bred to the work;

2*nd.*—The mature timber must be growing in compact masses.

The mature timber is so extremely scattered in even the best portions of the Deota Forest, that even if trained labourers could be imported, the adoption of this method of export would be out of the question. The circumstance that Deodar is not yet used for building purposes in the large cities of the Upper Doáb and the adjoining districts of the Punjab and Rájputána is against the plan of exporting scantlings other than railway sleepers. Although in Lahore and the Western Punjab generally Deodar is the chief wood used for buildings, its usefulness in this respect is not yet recognized in Agra, Meerut, Delhi and other cities in that direction. For the present, therefore, railway sleepers constitute the only form in which we can hope to utilize the outturn of this forest, and as regards carriage both broad and metre-gauge sleepers are exceedingly convenient. Under these circumstances, I will assume that timber will be exported in the shape of sleepers; and though I talk of broad-gauge sleepers only, they can be easily converted into their equivalent of metre-gauge sleepers.

Seven hundred and fifty trees may, as explained above, be expected to yield 15,000 sleepers, measuring 52,500 cubic feet. There is no doubt that this amount will be readily purchased, and we may reasonably expect to obtain Rs. 5 or Rs. 5-8

per sleeper at Agra or Delhi. The following figures have been furnished to me by the Conservator of Forests. They exhibit the amount expended in the forest on 520,000 cubic feet, which form the outturn of the last three years :—

	Rs.
Felling and logging	9,186
Sawing	71,086
Land carriage	63,593
Loss on food sold to coolies	13,673
Subordinate establishment	7,920
Valuation survey and protection from fire	2,162
Miscellaneous	1,489
Total ...	169,109

Distributed over 520,000 cubic feet, this gives 5·2 annas per cubic foot. There is no reason to anticipate that the proportion of these charges will increase considerably if works are contracted; on the contrary, it is probable that some of them will rather decrease as the demand for labour is diminished.

The floating charges to place of delivery (Agra or Delhi) have hitherto amounted to 6·5 annas per cubic foot, and may be expected to remain the same.

The timber must further be debited with an allowance for keeping the slides, roads and bridges in repair, and for extending them. This has been estimated at Rs. 8,000 per annum, which amounts to 2·43 annas for an annual outturn of 52,500 cubic feet.

Again, it has been stated that the slide may be expected to last 10 years, and hence 10 per cent. on the original outlay, or Rs. 2,600, ought to be debited to the annual outturn. This is 0·8 annas per cubic foot. The last item consists of what may be termed the general charges, and these are Rs. 4,500 on account of the lease of the forests in Native Garhwál, and Rs. 8,000 on account of Establishments and share of Direction charges: total Rs. 12,500—or, distributed over 52,500 cubic feet, 3·8 annas per cubic foot.

The following is an abstract of the rates per cubic foot :—

		Annas.	
1.	Charges in the forests	5·2	11·7
2.	Floating charges	6·5	
3.	Repairs and extension of slide, &c. ...	2·4	7·0
4.	10 per cent. on capital outlay for slide ...	0·8	
5.	General charges	3·8	
	Total		18·7

amounting, in round figures, to Rs. 4-2 per sleeper of 3½ cubic feet, and expected to realize Rs. 5. There is, therefore, a small margin of profit left. It is obvious that it will be more profitable to export twice the quantity in one year, as this will reduce the rates as follows :—

1 and 2	11·7
3 to 5	3·5
Total ...	15·2

making the cost per sleeper only Rs. 3-5, and leaving a margin of profit of Rs. 1-11 per broad-gauge sleeper. Whether it will be advisable to cut 1,500 instead of 750 trees annually in this forest, is entirely a question of Deodar reproduction, which cannot be settled until some further experience has been obtained. Meanwhile, it will be safer to limit operations to this smaller figure, and to endeavour by the exercise of the most rigid economy to reduce the cost of these operations, so as to increase the margin of profit.

Distribution of felling operations.

23. It will now be well to consider the question in what manner the cuttings during the next two years shall be distributed. The fellings in the Parthil and Temple Blocks being nearly completed, it will be most convenient to take in hand the adjoining blocks of Dopta and Katatách.

The Deodar-producing area of Dopta occupies about 180 acres, and the enumeration has given 2,921 first class Deodar trees.

Looking at the character of the forest in this block, it is probable that about 1,000 trees may be cut, which need not all be above 6 feet in girth, as at the elevation of this block (8,000 to 10,000 feet), and on the steep and precipitous ground which characterizes it, the rate of growth is slow, and probably many of the second class trees are of old age; hence it will be convenient to fix the minimum girth of trees to be cut at 5 feet. The principles which should guide the selection of trees to be cut in this block will be found detailed in the descriptions of compartments 1 and 3 appended to this report (Appendix A). The trees in the Dopta block are neither tall, nor of large girth, and cannot be estimated to yield more than 15 sleepers per tree. Some dry wood has been cut up in this block, but a good deal is still available.

After completing the cuttings in Dopta, the highest compartment (No. 5) of Katatách should be taken in hand. The general character of this block is similar to that of Dopta, and the enumeration has yielded 2,114 first class, and 4,123 second class Deodar trees. In this compartment, cuttings will probably be regulated by the same principles as in Dopta, and, taking the minimum girth at 5 feet, it is possible that owing to the precipitous nature of the ground, we shall only be able to remove 500 trees, which may be expected to yield 7,500 sleepers. The dry trees in Dopta and in this portion of Katatách may be expected to yield 10,000 sleepers. It is further proposed to complete the fellings in the Temple block, which may be expected to yield 70 trees or 2,000 sleepers.

The following is a summary of the estimated outturn in broad-gauge sleepers:—

	Sleepers.
Dopta block, 1,000 trees ... ... =	15,000
Katatách block, 500 trees ... ... =	7,500
Temple block, 70 trees ... ... =	2,000
Dry wood in Dopta and Katatách (compartment No. 5)	10,000
TOTAL ...	34,500

Provision has thus been made for a little more than two years' outturn, and this must suffice for the present. The cuttings above suggested will be made in the autumn of 1879 and 1880. The nature of the ground will probably make it advisable to roll the logs to the bottom of the valley, and there to cut them up. This will have many advantages; it will concentrate the sawyers' work, and facilitate the manufacture of charcoal in case it should be possible to commence iron making in the forest; but its chief advantage will be that the ground in the forest will not, as at present, be covered with refuse wood. This is a real difficulty in those parts of the Parthil and Temple blocks where a considerable area is covered with slabs, log-ends, branches, &c.

Disposal of Deodar wood which cannot be profitably exported — Iron making.

24. The disposal of the Deodar wood that cannot be exported is a question of considerable importance, as Deodar does not decay and will retard re-production for some time. An attempt has lately been made in the Parthil Block to collect this refuse in heaps; but this, if effective, is an expensive operation.

Endeavours will have to be made to discover good workable iron ore in the vicinity of this and other forests where cuttings are in progress. The ore will have to be carried to the places where the charcoal is made, but to this there is no objection; indeed, we find the magnetic ore of Kotkai and Dargoti is carried a distance of 15 miles to the villages where it is smelted. The charcoal will probably be made in large conical kilns which require the

proximity of water, and therefore it will be convenient, as much as possible, to collect the wood to be converted into charcoal near the streams.

Valuation surveys.

25. As explained in Mr. Rind's memorandum, the enumeration of trees of different classes has been effected by a system of tickets of different colours and with numbers, the colour indicating the girth-class, and the numbers the height-class. These tickets are pasted on a blaze cut into the bark of the tree, so that the class of each tree can be checked by the officer superintending the work. The counting, however, can only be checked by doing the work in each compartment over again. As already stated, the enumeration of Deodar had been nearly completed at the time of our visit in Parthil, Temple, Dopta, Katatách, Jaurási and Kánga; and it is supposed that before the close of last season the work in those blocks was checked and finished. I do not recommend that it be commenced in the blocks and compartments not yet taken in hand. The classification of trees is needlessly elaborate, and I doubt whether the results can be depended upon. In these blocks it will suffice to count the Deodar trees of the two classes above six feet in girth and between three and six feet in girth. This enumeration must be done under the personal supervision of the range officer, or any other superior officer who may be available for this work. The average length of the first class trees and the number of sleepers they will yield can readily be estimated for each compartment, or, if necessary, for each sub-compartment.

It is much better in work of this kind to obtain a few data which can be depended upon than to collect a large mass of figures which may or may not be reliable. I would also suggest that if a superior officer can be spared for the work, the trees of these two classes be counted in the compartments where the enumeration has been completed. If this enumeration should confirm the results already obtained, it will be satisfactory; if it modifies them, it will be useful to have correct figures.

Detailed description of compartments.

26. The chief aim which must be kept in view in arranging the cuttings in the Deota Forest must be to further the regeneration of the forest with Deodar as the dominant tree in those compartments where elevation and other circumstances are favourable for its growth. Over the greater portion the ground is too steep and rocky to admit of clearing and planting. In this forest we must rely chiefly upon natural reproduction, and selection fellings in patches will probably be the most convenient plan, as suggested in the description of certain compartments in the Patágni, Jaurási and Dopta Blocks appended to this report. The question whether such cuttings should be made in any compartment cannot alone be determined by an enumeration of the growing stock, but also requires an examination in detail of that compartment. The result of this examination should be recorded in the form indicated by the descriptions appended to the present report. The work of thus making an examination in detail of each compartment, and of counting the Deodar trees of the two classes indicated, will be an important work, which must be undertaken by the Range or other superior officer, as opportunity may offer. This work must not be delegated to subordinates. It should be completed if possible by autumn 1880. Based upon the detailed knowledge thus acquired of the different compartments, the Range Officer will not find it difficult to submit proposals regarding the continuance of fellings when the fellings now suggested shall have been completed.

Counting of annual rings.

27. It has already been stated that the annual rings have been counted on a large number of stumps in the Parthil and Temple Blocks, and it has been explained why the results obtained cannot be utilized. This work also must be done by the Range Officer, or other responsible officer if available. It is not necessary to count a large number of stumps in each compartment. If they are carefully selected as samples of average growth, 10 stumps in each compartment will give results sufficiently reliable. The countings made were taken on a mean radius, the mean radius selected being that which most nearly approaches one-sixth part of the girth. This is all right, and so was the form

of statement in which the countings were recorded, which has the following columns :—

1. Block and compartment.
2. Number of tree.
3. Girth on surface of stump.
4. Age of tree.
5. Number of rings on sections of the radius—centre to six inches.
6. Six inches to nine inches.
7. Nine inches to twelve inches.
8. Remarks.

Reducing factor.

28. Sixty-five trees had been measured by sections of 10 feet in the Temple and Parthil blocks, with a view to ascertaining the reducing factor required to calculate the contents of Deodar trees from their girth at breast high and from their length of stem. I do not give the results, as they should first be checked by further measurements made under the supervision of a responsible officer. It will probably be found convenient to determine separate factors for lengths of 50, 60, 70 and 80 feet. This and the counting of rings is work that must be continued as fellings progress, and the results will be extremely valuable. But no attempts should be made to collect such data through subordinates. It is not, however, work which presses, and which is required to arrange the cuttings to be made during the next few years.

Cultural operations.

29. The only cultural operation which appears to be pressing in the Deota Forest is the ringing of Spruce and Silver fir when they are associated with Deodar.

It must be borne in mind that when the contemplated impregnation works, for utilizing the inferior pines as railway sleepers, are set up it will probably be expedient to export Silver and Spruce fir sleepers. It will be better, therefore, not to ring any trees of these kinds in the lower parts of the Parthil and Temple blocks, which are conveniently situated for the export of timber; and for the present this work should be confined to the vicinity of the Deota Ridge and to the Kimári, Patágni, Jaurási, and Kánga blocks. Those compartments should be taken in hand first in which Moru oak is common, and in which the cover is so dense at present that no young Deodar can spring up. In those compartments where Moru abounds the ringing of the pines will not give much light, but it will give some help to the young growth of Deodar. Here, as in Lambatách, the work of ringing should proceed gradually. A few blanks in the vicinity of Katkat should be sown, as has been proposed in the case of Lambatách. No further cultural operations are suggested at present. Blue pine is not common, and although Moru oak does in a few places hinder the reproduction of Deodar, it is so useful a companion to it, that I do not propose to check its growth, and would rather first watch the effect of ringing Spruce and Silver fir in those parts where Moru oak is found.

Summary of work to be done in 1879-80.

30. The work to be done during 1879-80 may be summarized as follows :—

1*st*.—Fire protection.

2*nd*.—Ringing Spruce and Silver fir as indicated.

3*rd*.—Opening out the western forest of Bámsu and Surárs by inspection-paths.

4*th*.—Cutting into metre-guage sleepers all the available wood lying on the ground in the Temple and other blocks.

5*th*.—Felling operations as described.

6*th*.—Detailed examination and description of compartments; counting of the trees of two classes; counting of rings and measurement of trees by sections in the manner here suggested.

CHAPTER III.

JAUNSÁR-BÁWAR.

Rights of Government.

31. In briefly indicating what is to be done in the first and second class reserved forests in Jaunsár, it will be convenient to invite reference to Mr. Bagshawe's paper on "Forest rights in Jaunsár," published in the Forest Conference Report of 1875, pages 32 to 34, which gives a correct account of the rights of Government in these forests as laid down at the settlement of 1872.

Division into two ranges.

32. For the present it will be convenient to divide these forests into two great ranges, which may be designated as the northern and southern ranges. The northern, or Báwar range, should comprise all forests to the north of Karámba peak, *viz.*, those in the basin of the Dháragád, the northern portion of those in the Riknagád, and the forests drained by the feeders of the Darmigád and Kunigád. To this range should, for the present, be added the charge of the preliminary work for the survey, demarcation, and improvement of the Chir forests situated partly in Jaunsár and partly in Tiri-Garhwál on the left bank of the Tons.

The southern or Deoban range will comprise all forests south of the Karámba peak, including the forests in the basin of the Riknagád to the south of the Garagád, the whole of the forests in the basin of the Binárgád and its feeders, the forests on the Deoban-Karámba ridge and its branches, the chief of which is that running westward to Bodyar. In this range will also be included a number of second class forests, chiefly stocked with oak, in the southern part of Jaunsár; and the charge of the planting operations which must be undertaken to plant the available land within the limits of the Chakráta Cantonments.

Deoban Range.

Working-plan of 1875.

33. Attention is invited to the report entitled the "Preliminary working-plan of the Deoban working circle" of 1875. The forests which were then in a preliminary way defined as the "Deoban working circle" include a portion only of the Deoban range.

Demand for fuel and timber for Chakráta.

34. The supply of the fuel and timber demands of the Cantonment of Chakráta must, for many years to come, be regarded as the chief object to be kept in view in the management of this range. At present one regiment only is stationed at Chakráta, but the annual demand for fuel amounts to 101,800 maunds, which is equivalent to about three lakhs cubic feet of stacked wood. Experiments to determine the solid contents of stacked wood have not yet been made, but it is believed that 150 cubic feet of stacked wood (Oak and Fir mixed) are equal to 100 cubic feet of solid wood. The estimated annual requirements in fuel, therefore, would amount to 300,000 cubic feet of stacked wood; but as a matter of fact, owing to the circumstance that a full regiment was not always at the station, the actual consumption has not exceeded 200,000 cubic feet of stacked wood a year (equivalent to 133,000 cubic feet of solid wood) for the last three years.

The annual consumption of timber for building has amounted to 12,000 cubic feet, *viz.*, 10,000 cubic feet of Deodar, and 2,000 cubic feet of Spruce and Silver fir.

Besides these items, there is the consumption of fuel for lime burnt by the Public Works Department, for which the Pandáwa block has been assigned. Some trees have also been marked for this purpose in the Oak blocks south of Chakráta.

Supply of fuel and timber whence obtainable.

35. The first question which must now be considered is how to ensure the requisite annual supply of fuel and building wood for Chakráta. It will be best to assume the requirements in fuel to be 300,000 cubic feet stacked and in building wood to be 12,000 cubic feet per annum of which 10,000 cubic feet should be Deodar. Should a second regiment be stationed at Chakráta, the annual requirements in fuel would be higher.

The present sources of this supply are, 1*st*, dry timber which may be cut in all parts of the forest, and which may safely be estimated to supply annually 20,000 cubic feet stacked; 2*nd*, green trees, which as a rule should only be cut in those blocks which are protected against fire and grazing. It will, therefore, be necessary at once to consider the limits of the areas within a moderate distance from Chakráta which are actually protected against fire and grazing, and the additional areas which it may be possible thus to protect.

First, as regards distance; the area included on a large scale map (4 inches = 1 mile) prepared by the Forest survey, includes, with the exception of the Karámba block, all the forests which are sufficiently near to Chakráta to furnish fuel for the station. The area included in this map is 22,815 acres of first and second class forest, and of this area 17,000 acres are regularly protected from fire. The blocks which are allowed to be burnt are the following, *viz.*, parts of Inári and Moila near Bodyar, part of Missau and Chatri near Kanásar, part of Marauwa below Kanjátra, part of Mohna, Karáli, part of Rikta, Dulyána, Dánda, Ekra, Kulered and Amlokri east of Ekrapeak.

All these blocks which are allowed to be burnt are nearly bare, precipitous, or so distant from Chakráta as not at present to be workable for fuel.

The following areas are closed against grazing:—

	Area in acres.	Closed since.
Bodyar	1,460	1870
Konain	536	1871
Kanásar	177	1873
Mohna	800*	1873
Mátkángra	600	1874
Thona	469	1878
Siári	150	1878
Total ...	4,192	

The station of Chakráta was formed in 1869, and the experience gained since that time has proved beyond doubt that where sheep and goats are allowed to graze, no fresh young growth comes up; the only exceptions being blocks where grazing is very light and not continuous. In many blocks, young growth of older age than the commencement of the cuttings is found, but in no place, where cuttings have been made since that time, have seedlings of a more recent date come up unless protected from sheep and goats.

Annual yield of blocks closed against grazing.

36. It would be ruinous to make any cuttings in places which are not closed against sheep and goats. Hence the first point to be considered must be the estimated annual yield of the blocks closed against grazing.

For this purpose I propose to consider the total quantity of mature wood which may be cut out before the young growth, poles and half-grown trees have attained maturity. The length of the period which this mature wood must last cannot at present be determined, and no attempt at determining it will be made. But it is necessary to form an approximate estimate of the quantity of mature wood at present available.

Estimated quantity of mature wood at present available in the following blocks:—
1st—Bodyar.

37. Bodyar contains a large area of grassy slopes with a small extent of young forest, chiefly Deodar, with a little Moru and Spruce. No Moru should be cut in this forest, for it will prove a necessary companion of Deodar, But in those portions where Spruce predominates or forms about one-half of the mature crop, mature trees of this species may be cut out, and it may be estimated that this will yield altogether about 60,000 cubic feet of solid wood. Care must, however, be taken not to cut any Spruce trees which are isolated or standing on the edge of blanks. Wherever Spruce is cut and in a few other places in the midst of poles of Deodar, a number of mature Deodar trees may also be felled, and these are estimated to yield 10,000 cubic feet of timber.

* This includes about 100 acres of Kharsu forest on the Deoban Hill above the Tons road.

38. The area closed in the first class reserve of Konain has been increased by the closing of about 150 acres in the Siári block adjoining Konain on the west. The total closed area, therefore, amounts to 686 acres. The southern slope is incompletely stocked with Deodar, and no cuttings are here advisable. The lower part of the northern and western slope is incompletely stocked with Deodar and Blue pine, with a few Moru oak. Here a number of dead and damaged trees of Kail and Deodar, chiefly the result of temporary ("khil") cultivation, may be taken out. The upper part of the northern slope is well stocked with a complete crop of high forest, consisting of Spruce and Silver fir with a sprinkling of Moru oak and Deodar, the latter being more numerous on dry ridges. Here heavy cuttings of Spruce may be made, the Moru oak and Deodar being spared, but the ground should nowhere be denuded. An experimental cutting was made about 1¼ miles away from Jimuth over an area, known as Choli, of about 7 acres on a gentle, moist, northerly slope, all Moru and Deodar being spared. The ground was planted and sown up with Deodar, partly during March last, and partly during the rains. The plants were sheltered during the autumn with "cowls" of grass, and will probably succeed, but they would probably have been more certain of success had a portion of the Spruce fir been spared for the sake of shelter. In all cuttings of Spruce in this block care should be taken to leave groups of trees and poles more or less compact. The area in this block over which fellings may be made is estimated at 250 acres. The cuttings on this area are expected to yield 200,000 cubic feet of Spruce (solid wood) and 10,000 cubic feet of Deodar timber. 2nd—Konain, including a part of Siári.

39. This is a small first class forest of pure Deodar with a little Kail, Spruce and Moru, which must not be touched. A few old Deodar trees may, however, come out, and these are estimated to yield 5,000 cubic feet of timber. 3rd—Kanásar.

40. The cuttings suggested in para. 23 of the Report of 1875 have been made, and have yielded 533,365 cubic feet of stacked wood (Oak and Fir), of which 251,830 cubic feet were Oak (see Appendix C). The cuttings were made over an area of about 311 acres; allowing for blanks, about 250 acres remain to be cut over, and this area is expected to yield 100,000 cubic feet of solid wood. The compartments in which cuttings were made are situated between the Mohna and Deothát roads, and here the forest consisted chiefly of Spruce mixed with Kharsu in the upper, and Moru in the lower portions. The plan followed was to spare Moru, but to cut Kharsu freely, and to spare the Spruce and Silver firs where they were mixed with the latter. The cuttings were made in 1876 and 1877. As regards growth of seedlings, these cuttings have not as yet had any effect. On the other hand, it cannot be denied that the light let in has increased the undergrowth of herbs and shrubs to a great extent. The portions in which fellings have still to be made are situated above the Deothát road, and consist of Kharsu forest partly pure partly mixed with Spruce. There is also the basin drained by the Kua stream, which furnishes the Chakráta water-supply, and here the forest consists of Kharsu and Spruce in the upper, and Moru and Spruce in the lower part. 4th—Mohna.

It will be convenient in future to include in the Mohna Block the top of the Deoban hill above the Tons road, parts of which have hitherto belonged to Kanjátra and Jádi. The whole of this area is protected against sheep and goats.

41. Regarding the plan of cutting in Mohna, within the extended limits here suggested, the following should be noted. In the high forest of pure Kharsu below Snow View, the first step should be to give light by cutting out all trees which are suppressed or have an imperfect crown, or are otherwise not growing vigorously. Sufficient light should be given to enable the seedlings of Kharsu, which in parts cover the ground, to grow up; but the thinning should be moderate, so as to guard against the growth of herbs and shrubs. The chief disadvantage of this plan is, that it will necessitate a fresh felling within a short time after the first, but it should be made as an experiment, and limited to the compartment below Snow View. The result should be watched with the view of ascertaining when the more extensive cutting contemplated, as explained on page 20 of the report of 1875, should take place. Where System of felling recommended for Mohna.

Spruce and Silver fir are mixed with Kharsu, as in the upper part of Kanjátra above the Tons road, these trees should be spared, and here a larger proportion of the older Kharsu trees should be cut out. In the lower portion of this part of the forest, there is a heavy growth of young Silver fir, and here most of the mature trees may be taken out. With regard to the remainder of the cuttings in the Mohna block, it will suffice to say that they should be sparingly conducted, and that Moru, Spruce and Silver fir should be spared as much as possible. The total quantity of mature wood that may at present be cut in Mohna is estimated at 100,000 cubic feet (solid).

Estimated quantity of mature wood available in the Thona block.

42. This block has only just been closed; in a portion of it cuttings were made in 1869 and 1870. About 250 acres of well-stocked forest below the Missau road and above the Bodyar road are untouched, and this area is expected to yield 150,000 cubic feet of solid wood.

Mátkángra.

43. In Mátkángra 600 acres have been protected, but owing to previous heavy fellings, and the extensive blanks, there are no mature trees that can be removed.

Summary of mature wood available in blocks protected against grazing.

44. The following statement gives a summary of the areas in which cuttings are proposed in these blocks, and the wood expected to be obtained:—

Blocks.	Area in acres	Cubic feet of Spruce and Oak (solid).	Cubic feet of Deodar (solid).
Bodyar	1,460	60,000	10,000
Konain with part of Siári	250	200,000	10,000
Kanásar	177	...	5,000
Mohna	250	100,000	...
Thona	250	150,000	...
Mátkángra	...	...	...
Totals ...	2,387	510,000	25,000

This is equivalent to 765,000 cubic feet of stacked fuel and 15,000 cubic feet of Deodar in scantling, estimating the loss in conversion at 40 per cent. This will suffice to furnish about 1½ years' supply of Deodar, and if the yield of dry wood to be cut over the whole area is taken into account, the quantity expected, *viz.*, 765,000 + 50,000 cubic feet of stacked fuel, is equal to a little more than 2½ years' supply. Cuttings should be commenced in Bodyar, Mohna, and Konain.

Thona, having only just been closed against grazing, should be put back until the cuttings here proposed have been completed in the first-named blocks.

Proposal to close parts of Hajáwá and Bajamára against grazing.

45. It is evident that in order to secure a continuous fuel supply for Chakráta, the area closed against sheep and goats must be increased considerably. There are only two blocks within moderate distance, and well stocked with wood, which may at once be closed without great hardship to the people. These are the central portion of Hajáwa, estimated to measure 500 acres, and Bajamára, above the Kailo road, estimated to cover 250 acres. The Hajáwa forest is described in paragraph 30 of the Report of 1875. Sufficient grazing ground above and below the closed portion will be left open to the villages of Duár and Mohna, the cattle of which are in the habit of grazing there. The forest does not contain Deodar, and the cuttings should be regulated with the sole view of ensuring a rapid reproduction of Spruce and Silver fir, with a mixture of Oak. It is estimated that the cuttings made to ensure this object will yield 750,000 cubic feet of solid wood.

The portion of Bajamára which it is proposed to close is at present grazed over by cattle belonging to the villages of the Kailo Khat; but they have considerable grazing areas to the north and south, and in the lower part of Bajamára. The forest consists of Spruce, Silver fir and Deodar, with Kharsu at the top, but parts of it are rocky precipices, and only light fellings can be made, the outturn being estimated at 25,000 cubic feet (solid measurement) of fuel, and 5,000 cubic feet of Deodar timber.

The total yield in mature wood of these two blocks will be 775,000 cubic feet of solid or 1,162,500 cubic feet of stacked fuel, which with 80,000 cubic feet of dry wood will add another four years' supply; but it must be remembered that this additional quantity could not possibly be cut out in the course of four years and that it would have to be spread over a much longer period. The addition of these two blocks would raise the protected area to 4,942 acres, which, as explained, is estimated to contain sufficient mature wood to provide fuel for 6½ years, and Deodar for 1½ years. Should it be decided to close Hajáwa, then cuttings should commence in this block, as they would have to be spread over at least 15 years. In that case the cuttings in Konain would be postponed.

The closing of additional areas must be considered.

46. It is evident that the closing of further areas must be taken into consideration. In order to do this, however, it will be necessary to review the actual pasture requirements of the khats adjoining the forests which supply fuel to Chakráta. The requirements of the following khats must be considered:—Dhanau, Bharam, Missau, Kailo, Bislár, Duár, and Mohna; and it will be necessary to collect statistical data regarding the number of sheep and goats habitually kept by the villagers of these khats. It is only the local sheep and goats which have to be taken into consideration, as no herds from beyond the snowy range come for pasture into this part of the hills.

Closing of Kanjátra, Asmári, Kophti, and parts of Duráni and Missau.

47. The object aimed at will be the closing of Kanjátra, the upper portion of Duráni, Asmári, Kophti and the portion of Missau adjoining the Manjaun khad. The total area of these blocks is 3,800 acres, but the closing of only a portion of this area is contemplated, *viz.*, about 2,200 acres. The closing of this area is important on account of the convenient position of these blocks for export of fuel; but the present stock of mature wood growing in them is not considerable. Kanjátrá may be estimated to yield 80,000 cubic feet, Duráni 84,000 cubic feet, and the other three blocks together 390,000 cubic feet, giving with the annual yield of dry wood a supply for three years at 300,000 cubic feet of stacked fuel per annum. It will not be possible to close these blocks without assigning to the khats concerned high level grazing areas at greater distances, and the inconvenience which this will entail on them must probably be compensated by the payment of money, and the grant of forest land in the vicinity of the villages concerned. Such forest land is available in Kutniar and part of Jádi for Dhanau; in the Missau block for Missau; in the Leguna and Karáli blocks for Kailo; parts of Mohna, Hajáwa and the Ekra blocks for Mohna; Kulerod, Amlokri and Dánda for Duár; part of Hajáwa, Duliyana, and Rikta blocks for Bislár. On this area the wood which is at present fit for cutting is expected to be sufficient to provide three years' fuel supply for Chakráta. If these arrangements are made, the total area closed against grazing will aggregate in round numbers 7,000 acres. No reliable estimate can be framed regarding the future yield of this area; but having regard to the present growing stock, elevation and soil, it does not appear unreasonable that it will yield at the rate of 20 cubic feet of solid wood per annum per acre, or a total annual supply of 140,000 cubic feet. After this area has been improved by continual protection and planting up, the yield ought to be considerably higher.

Karámba.

48. It is obvious that in case a second regiment should be stationed at Chakráta, some further provision must be made; and this can only be secured by adding to the forest area at present taken in hand, the Karámba block which is situated south-east of Karámba peak, and east of the main ridge, and occupies the northern slopes of the Garagád valley. The area of this block is 1,600 acres; it is distant from all villages and not much grazed over. This

block should be taken in hand at once, and protected from cattle and fire; inspection-paths should be made through it, and the dry wood should be utilized as much as possible.

Pandáwa.

49. Outside the area protected, and proposed to be protected, is the Pandáwa block, which is at present in the hands of the Public Works Department of Chakráta, the wood being used for lime-burning. It is protected against fire, but is grazed over. The area of this block is 418 acres, and it is not proposed to interfere with existing arrangements.

Recapitulation of proposed arrangement for the supply of fuel.

50. Recapitulating the chief points of the present forecast of the yield of timber and fuel for Chakráta from these forests, the following points should be borne in mind. An annual yield of at least 20,000 cubic feet of stacked wood may be expected from dry and fallen trees in the whole forest area, sufficiently near to be worked for the fuel-supply of Chakráta. The area at present closed aggregates 4,192 acres, and the mature wood growing on it, which may at present be removed, will, with the dry wood mentioned, furnish the fuel-supply for two and a half years. Two additional blocks, Hajáwa and Bajamára, aggregating 750 acres, may be closed at once, and they will add four years more supply of mature wood. Five more blocks, measuring 2,200 acres, may be closed with some difficulty by assigning more distant grazing ground to the villages concerned, and by giving them Forest land as compensation. The mature wood contained in these blocks will secure three years' additional supply. Thus the growing stock on this area at present fit for cutting will provide fuel supply for Chakráta during a period of nine and a half years. By the time that the mature wood in the areas here indicated has been exhausted, a sufficient portion of the smaller trees and poles will have attained maturity And as already stated, the aggregate closed area of 7,000 acres may then be expected to yield 140,000 cubic feet of solid, or 210,000 cubic feet of stacked wood a year, and this yield may confidently be expected to increase as the forests improve. In addition to these there is the Karámba block of 1,600 acres almost untouched; so that if these proposals are accepted, the future supply of the requisite fuel for Chakráta appears to be secured.

Supply of Deodar timber

51. It has been already stated that the blocks now protected are expected to yield one and a half years' supply of Deodar timber. The present Deodar supply is brought from Páni Kinai and Bhujkoti, which are not protected against sheep and goats, but they are only lightly grazed over. The trees already felled in these two blocks will yield a year and a half's supply, but no more trees should be felled in any blocks which are not closed against grazing. The mature Deodar wood available is, therefore, expected to furnish sufficient for three years' consumption, and if more is required, it must be brought from more distant forests, probably from the closed portions at the head of the Dháragád.

Plan of cutting.

52. A few general remarks should now be made regarding the principles which should regulate the cutting out of mature trees in these forests during the next few years. It has already been laid down as a fundamental principle that, as a rule, no cuttings shall be made in blocks which are not protected against fire and grazing. In other respects attention may be invited to what was said on this subject in the report of 1875, but it seems desirable here to add one suggestion to the remarks then made.

The cuttings throughout this area must for the present have the character of selection fellings, as the character of the forest does not yet admit of successive cuttings by compartments; but instead of cutting out isolated trees here and there, it will be an advantage rather to make clearances of some extent, provided the ground is favorable for reproduction, and the surrounding forest is sufficient to provide the needful seed and shelter.

The area of individual plots cleared cannot be laid down by any hard-and-fast rule. It must entirely depend upon the circumstances of each case, and it is not intended to prescribe that every tree shall be cut out in these clearances. Thus, in coniferous forests it will be an advantage to spare all Moru trees, and generally it may be laid down that not only all young growth of whatever description, but also groups of poles and immature trees shall be spared.

What is intended by this system is to imitate in an improved manner the clearances made for temporary cultivation in these hills and in other parts of India, which if surrounded by good forest are found to clothe themselves with young growth in a satisfactory manner. It is intended to cut out all mature trees in such plots, but to leave the younger growth on the ground. Obviously this system of cutting in plots is not applicable where grazing is permitted, hence it was not proposed in the report of 1875, which report still contemplated the necessity of continuing cuttings in forests grazed over by sheep and goats. Nor is the system of cutting out by plots applicable on precipitous and rocky ground, and other places where the conditions of reproduction are unfavorable. With these remarks the carrying out of the fellings in these blocks for the next few years must be left in the hands of the Officer in charge of the Deoban range.

In the present state of our knowledge regarding the requirements and mode of growth of the trees composing these forests, it would not be expedient to lay down any further rules on this subject. The chief point which must be kept in view in this matter is to ensure a complete and rapid reproduction of the forest and, where Deodar is found, the growth of this tree should be favoured. It will be understood that these remarks only relate to the reproduction of the forest from self-sown seed, and not to the treatment of coppice woods.

Coppicing of Kharsu and other trees.

53. It is not likely that any considerable portion of the fuel requirements of Chakráta can for the present at least be met from coppice woods. In the area under consideration Kharsu is the chief species of oak, and the experience now gained on the sample areas cut in March 1875 to test the coppicing power of this tree is clearly unfavourable. The stumps of old trees have not produced any shoots, and the average length of the shoots produced by trees up to four inches in diameter is only three feet, which is a very poor result for four years' growth. The growth of Kharsu at this elevation is slow and trees of a diameter of four inches are probably, on an average, not less than 20 years old. At a lower elevation the reproduction by coppice of this tree may be found to be more favourable, and it may perhaps be found possible to produce fuel from coppice of Moru, Bán and other trees. This subject requires careful study, but need not now be dwelt upon.

Planting operations.

54. The extent of grassy slopes and other blanks in the forests selected to supply the requirements of Chakráta is very considerable, and planting and sowing must now be vigorously taken in hand in order to fill up these blanks in as short a time as possible. Within the area closed and proposed to be closed the following may be indicated as the principal fields for operations in this respect:—

	Acres.
Within cantonment boundaries...	600
Mátkángra	100
Bodyar	600
Bajamára	50
Choli	50
Jádi	100
Mohna	200
Dáina	300
TOTAL ...	2,000

The following remarks only relate to those areas where this work is most pressing.

Planting in Cantonments.

55. *The Cantonment.*—Here an area of 600 acres has been selected to be operated upon by the Forest Department. Regarding its management sufficient has been said in the report for 1875. It is important that operations should be commenced early, as the elevation is low and the slopes favourable to planting. It is not impossible that trees may here be raised which will coppice well, and this is important in the vicinity of cantonments. It is understood that under the orders of Government on this subject the funds for these

operations will be found by the Forest Department, and the proceeds credited to Forest Revenue. In fact, the understanding was that the lands planted up in Cantonment limits would be placed temporarily in the charge of the Forest Officer, who should, as regards all matters relating to cantonments, act under the orders of the Commanding Officer.

Work accomplished.

56. The following results have been observed in a small area planted within Cantonments on one of the eastern spurs by the Military Authorities. The planting of acorns of Bán, mentioned in paragraph 11 of the Report of 1875, has succeeded very well; the lines are fairly stocked and the trees are from 6 to 12 inches high. Cattle seem to have got into the area planted some time ago, and hence the plants are in places nibbled and stunted, but the protection from fire of the area planted has been complete. It is satisfactory to notice an increase in the shrubs, such as *Andromeda*. As suggested, in the Report of 1875, this and other bare spurs should be planted up with Kail (*Pinus excelsa*) as an experiment. It is possible that this tree may not attain any great age, but then it may be cut out after having done its duty as a nurse. Kail should be sown in horizontal lines as described elsewhere, the patches sown being so selected as not to interfere with the growth of trees and shrubs existing on the ground, which should be maintained, as it will serve to draw up and give shelter to the Oak. On the northern slopes of the spurs in Cantonments, where there is already a certain amount of trees, such as Bán, &c., it was recommended in the Report of 1875 to interplant Deodar in lines, but an attempt should here also be made to raise Kail. By way of experiment, *Eucalyptus globulus* has been planted to some extent in the station, but is cut down every year by the snow. It should have a trial on the lower slopes, as well as the two Australian *Acacias*, *A. dealbata* and *A. melanoxylon*; otherwise the suggestions of the Report of 1875 may stand.

Planting in Bodyar.

57. Bodyar.—Here considerable progress has been made in raising Deodar, and it may be said that both the system of sowing in patches and of transplanting from nurseries is now well understood, and that in favourable localities failures are now the exception. This is a very important step in advance, which has been accomplished since 1874, and the success which has been obtained in this forest should now be steadily followed up, and the blanks still remaining in Bodyar should be filled up within the next five years. During this period, Bodyar will present an excellent field for employment of probationers and apprentices, and operations should be organized on a systematic plan. For this purpose it is first of all necessary to divide the forest into compartments. The forest divides itself naturally into three main bays, Bodyar, Remuwa, and Thowa, which are separated by two prominent ridges. Bodyar and Thowa may be sub-divided into two or three compartments each, so that the whole block will then consist of from five to seven compartments.

Progress already made in planting and sowing the Bodyar block.

58. It will be convenient here to record the progress made in planting operations since their commencement. The first attempt at planting was made in 1872, when Mr. Whittall, then in charge of the Deoban range, began sowing in horizontal lines three feet apart, which were dug up continuously along the slope of the hill on all aspects, and sown in November and December of that year. Where the plants came up too thick they were thinned out at the beginning of the following rains, and the young plants were used to fill up blanks in the lines. The slopes below the forest hut, and the first ridge to the north-west of it, an area of about 150 acres, were operated on, the results being very unequal. The seeds came up well, but unfortunately the rains of 1873 were late, and a large proportion of the young plants dried up. What now remain are patches of healthy and vigorous plants, chiefly on slopes with a northerly and north-westerly aspect. The average height of these plants may be put down at two feet. They are six years old, and the average rate of growth has therefore been four inches per annum. The terminal shoots of last season were between six and twelve inches long in the best portion, and some of the plants are over three feet high, with a diameter at the base of three-fourths of an inch, shewing the six rings in the wood very distinctly. In

1874, this system was considered to have failed, and nurseries were established with a view of employing transplants. The first nurseries were established at the bottom of valleys in localities exposed to frost; the nurseries were not properly prepared, and these operations were failures. Nurseries on an improved plan and in more favourable localities were established in November and December 1874, and they were added to in 1875. The seed was sown in November and December 1874 and 1875, and the young plants were bedded out in the rains. A few were planted out in the rains of 1877, but planting was stopped because the rains ceased early. The majority of the plants were put out in the rains of 1878, and appear to be doing well. In November and December 1875 another system was commenced. On favourable slopes, patches were dug about 10 feet apart, and in each patch about 40 seeds were sown. These patches were made in the southern part of the Bodyar bay, and have succeeded well. The plants are on an average six to nine inches high with well-formed roots. In 1876, patches were made in continuation of the former lines in the Bodyar bay, both on favourable and unfavourable slopes; the former succeeded, the latter were a failure. In 1877, patches were made on favourable slopes in Thowa, Remuwa, and Bodyar, and the seed was sown in November and December; about 15 seeds were sown in each patch. Shelter was given by branches in all exposed places early in spring, and the success has been good, due partly to the very favourable rains of 1878. The plants are one to two inches high, and are healthy and vigorous. A good sample of this sowing in patches is to be found on the Mundia ridge on a slope facing north-west.

59. The work remaining to be done in Bodyar is—

Planting and sowing operations to be carried out in Bodyar.

1*st*.—Plant out all available plants from the nurseries into the holes already dug, the Moru plants being put out on moist and somewhat sheltered slopes in the southern half of the Bodyar bay. This work should, as much as possible, be completed this autumn and what remains should be done in March. Natural reproduction may be relied on to fill up the blanks, left after the completion of this operation, in the southern portion of Bodyar.

2*nd*.—Prepare patches in lines, the lines to be according to circumstances 20 to 30 feet apart, the distance between the patches in the lines being regulated by the nature of the slope and other circumstances. In each patch about 12 seeds should be sown. The chief point to be attended to in this system is to select the patches in the most favourable places where moisture is likely to be retained longest; thus places sheltered by rocks or shrubs should be preferred, and all places should be avoided where the rock is close to the surface. The lines will be interrupted wherever trees or rocks are in the way, and no rigid rule can be laid down regarding the distance of the patches from each other; but on even and favourable slopes they may be about 3 feet apart. These patches may be prepared at once, and the seed may be sown either in November and December or in February and March. The advantages of operating in horizontal lines, in the manner here suggested, have been explained on another occasion and need not be again set forth. In this manner the whole of the blank slopes in the northern part of Bodyar should be completed, the rocky portion of the minor spurs being left untouched. The bare slopes on the north face of the Mundia ridge should also be treated in this manner. So much should, as far as possible, be completed this autumn and next spring, and the work for autumn 1879 and the succeeding years will then be to complete in the same manner Remuwa and Thowa, excluding all precipices and rocky slopes. Kail does not grow well in Bodyar, and generally does not seem to thrive well on limestone. There are, however, some slopes in the southern part of

Bodyar covered with young Kail which seem to do well; an attempt should therefore be made to raise a proportion of Kail, particularly in those localities where the rock is shale. It is recommended that here alternate patches be sown with Kail and Deodar, until experience may indicate a modification of this plan. It is most desirable to prevent Bodyar from growing up into a pure Deodar forest. The patches should be sheltered from frost and sun by branches. Whenever Moru seed is available, seeds should be dibbled into selected patches, it being borne in mind that Moru will not thrive on sunny slopes, the young plants requiring shelter and moisture. By way of experiment patches here and there should be sown up with cypress seed. All patches should be sown with seed of one kind only; it is not recommended to sow two kinds in one and the same patch.

3rd.—A nursery should be prepared every year to raise a certain number of Deodar and Moru plants, which may be used to fill up any patches that have failed in the operations of previous years. In the selection of localities for nurseries frosty hollows should be avoided; the vicinity of water and some trees for shelter are an advantage. Nursery beds should be made, be about four feet broad, sifted earth about six inches deep being heaped up on a hard bottom. Seedlings should be bedded out as early in the rains as possible, in the first or second year according to circumstances, and in lines 12 inches apart, the plants being about three inches apart in the lines.

Sowing in Bajámara.

60. The work next in urgency, which should be completed this autumn and next spring, is to sow up certain extensive bare slopes in two places in the Bajamára block, above the road, estimated to aggregate about 50 acres. This is to be all Deodar, and the sowing is to be in lines as prescribed for Bodyar. Where there is no growth on the ground these lines may be placed as near as 15 feet apart.

Sowing in Choli, part of Siári block.

61. A third piece of work which must be done as soon as possible is to sow up the clearance which was made in the forest of Choli a few years ago, and which has been partly planted partly sown as already mentioned in patches 10 feet apart; but this operation should be supplemented where necessary by horizontal lines laid through the whole plot at a distance of 30 feet apart. Efforts should be made to have these lines as complete as possible; they will require careful protection against frost and sun. In selecting these patches advantage should be taken of existing shrubs and other shelter as the soil is light and apt to dry up. The sowings here must all be of Deodar.

Sowing in Jádi.

62. After the work in Bajamára and Choli has been completed, the upper part of Jádi below the Tons road should be taken in hand. Fellings were made here in 1868, and though the fellings were by no means excessive, there is no reproduction, and the place is covered with ringál and shrubs. The patches should be in lines as prescribed, and I suggest that alternate patches of Spruce and Silver fir be sown with occasional patches of Kharsu oak. A nursery should be established somewhere in Mohna, whence plants may be obtainted for filling up any blanks in this operation.

Sowing and planting in Mohna.

63. After Jádi has been completed, the sowing and planting up of Mohna should be taken in hand, and it will be most convenient to commence in the southern portion of the block, working gradually towards Kaunti Láni. The operations should here as elsewhere be carried out by sowing in lines, any failures being afterwards filled up by nursery transplants. For this purpose a nursery in a convenient locality, near water, and at a medium elevation, should be established; this nursery will yield plants for the operations in upper Jádi and Mohna.

Sowing in Darna.

64. The northern face of the Gobrás Dhár, which is the most valuable part of the Darna block, is incompletely stocked with Moru and a few Spruce,

and it should be sown up with Spruce and Deodar, experiments being made with Cypress.

General remarks regarding planting and sowing.

65. As regards the time when the operations in Cantonments, in Mátkángra and Dárna, should be taken in hand, nothing definite can now be fixed. This must depend on circumstances; but after a considerable portion of the work to be done in Bodyar has been completed, it will be convenient to have some operations going on in one of these three localities. The ground in Cantonments should be taken in hand first, and, if possible, it should be completed before the work is extended to Mátkángra and Dárna. If these suggestions are carried out it will probably be possible to plant up 2,000 acres in the localities mentioned within from 10 to 15 years. Operations should, if possible, be so arranged as to have work going on in not more than two or three blocks at the same time. It will be noted that, for the present, it is proposed to confine all operations to Deodar, Kail, Spruce, Silver fir, and the Oaks. But this must not be held to exclude the experimental cultivation of other trees in suitable localities. Thus the Horse-chestnut and the Bird-cherry *(Prunus Padus)* are both fast-growing trees, which are likely to thrive in moist places on rich soil; but they and other species should only be tried where the conditions appear favourable for their growth. In the same manner, Cypress should be tried on limestone, and the large Maple *(Acer cæsium)* on high and exposed slopes.

Fencing in Duráni block.

66. In the Duráni block, at the head of the Kaunti Láni khad, several fellings were made in 1870 and 1871, and there is no reproduction whatever. Something must be done to induce young growth to come up, and it has been decided to form an area of about 50 acres: this should be done at once.

Báwar Range.

Chief work in the range.

67. The chief works in this range will be the care and working of the Chir forests which are to yield the sleepers proposed to be impregnated, and the management and improvement of the Dháragád and Riknagád Deodar forests. After this work has progressed to some extent it will be desirable to examine the slopes on the north and west sides of Kedár Kánta. This is a remarkable extent of forest on gentle slopes with exceedingly rich soil, consisting chiefly of Silver fir and Spruce, with Horse-chestnut and other deciduous trees, the three Oaks, a fringe of the Alpine Birch at the top and a sprinkling of Deodar in the lower part. The examination of this forest is desirable on account of the Deodar it contains, and also because it is impossible to say if the Spruce and Silver fir will or will not eventually be wanted for conversion into railway sleepers.

Chir forest on the Tons.

68. The extent of the area of *Pinus longifolia* forest to be selected must depend upon the following considerations:—in the event of arrangements being made to impregnate the wood of *Pinus longifolia* for the use of railways in India, it is proposed to send down annually from the Tons Forests 100,000 broad-gauge sleepers, or their equivalent in narrow-gauge sleepers, amounting to 350,000 cubic feet. Considering that the Chir forests are fairly well stocked, and are pure, it may be assumed that they will yield at the rate of 20 cubic feet per acre annually. This would require an area of 17,500 acres; but allowing for precipices, rocky ground, and blanks, it will be safe to demarcate and place under protection a total area of about 30,000 acres, which should be in the vicinity of the the Tons river, and such of its feeders as may admit of floating. It is believed that this area can be obtained on the left bank of the Tons, between the mouth of the Dhármigád and Gurugád. After a skeleton map on a large scale has been obtained, the first work will be to determine roughly the total area to be taken in hand, then to begin fire protection in one corner, and, at the same time with fire protection, to make a system of inspection-paths.

The management of these Chir forests will be a much more simple business than the management of the higher hill forests, as they are pure, and also because there are no villages in them or in their immediate vicinity. It should

be remembered that fire protection in them, and probably also their improvement otherwise, will be greatly faciliated by the encouragement of the growth of Oak (*Quercus incana and dilatata*) and of deciduous trees in their midst. The natural reproduction of these forests will present no difficulty, the Chir seeding freely almost every year. These seedlings under the present régime of fires are annually burnt down, but under fire protection all that is wanted is to give light for them to come up.

Chir requires and stands more light than any of the other coniferous trees of these hills, save *Pinus excelsa*. When young the cover of its thickets is dense, but as it grows older the cover gets broken, and unless there is an undergrowth of Oak and other trees a growth of high grass is unavoidable, and this makes fire protection difficult. Hence, it is desirable to encourage the growth of Oak and other trees. The area taken in hand this season for fire protection and improvement should at once be divided into suitable blocks and compartments, care being taken not to make the compartments too small. It will be convenient to draw up at once a brief description of the blocks and compartments formed in the area thus taken in hand.

Road from Saiah *viâ* Sangoti and Tiuni to the Chir forests.

69. In order to faciliate access during winter to the Chir forests on the Tons, it will now be necessary to make a path *viâ* Saiah, Sangoti and Tiuni at a lower level than the present Tons path. It is understood that on a part of this line an old road already exists; and to open out the proposed line of communication will entail the making of about 16 miles of new paths and the widening of 12 miles of the existing Tons path. This work should be taken in hand at once. In the first instance, it will suffice to open out a two-foot path along which ponies can be led.

Forests at the head of the Dháragád and the Riknagád.

70. The forests at the head-waters of the Dháragád and Riknagád are of great importance. on account of the large quantity of Deodar they contain. It is roughly estimated that they will be found to contain as many first class Deodar trees as the Deota Forests, and in view of future possible demands for Deodar, their improvement should at once be taken in hand both as regards protection from fire and grazing.

This area comprises the three first class forests of Katián (611 acres), Totwa (803 acres), and Lakau (1,440 acres). These have been protected against fire since 1870, and the two first-named blocks against pasture since 1871 and 1872. In addition to this area a great portion of the Deodar-producing tract has been protected against cattle and fires, so that a total area of 3,000 acres is now under protection. In addition to this there are two Deodar-producing tracts not protected, *viz.*, the western portion of Lakau and the northern portion of Lakua and the whole of Hariánta. An effort should be made to protect if possible the whole Deodar-producing area against fires and grazing. In addition to these there are the forests on the upper portion of the Riknagád, measuring about 4,500 acres, which have been protected from fire since 1873, and from pasture since 1878. This area, however, does not all produce Deodar, but contains Spruce and Silver fir near the ridge on the northern slopes. The working of the Riknagád forests will present some difficulties; therefore nothing is contemplated but the continuance of protection. But as already mentioned, the forests on the Dháragád should be at once divided into blocks and compartments, and the system of inspection-paths should be completed. It is believed that it will not be difficult to make the Dháragád fit for floating.

In this range some very successful planting on a small scale has been made at Katián, where a nursery of Deodar was established in 1873. The plants were put out on a northerly slope in 1876, above the Tons road near Jákni Iáni. The success is not so marked as at Bodyar, owing probably to less careful supervision. Hereafter, when an officer is available for this range, sowing in lines may be taken in hand in the vicinity of Katián, on the easy slopes which are now incompletely stocked with Grey oak and Blue pine. No further planting operations are to be taken in hand in this range at present,

General remarks on the work to be done in the Jaunsár Forest Division.

Description of compartments.

71. Some progress has been made in dividing certain blocks in the Deoban range, and on the Dháragád, into compartments, and in preparing a descriptive account of them. The work done in this respect in the Dháragád, Mohna, Kanjátra, Thona, Asmári, and Kutniár forests is a good move in the right direction; but it will be necessary to revise it in several respects. The compartments selected are generally much too small for present requirements, and the descriptive account is too long. It must be borne in mind that we are only now laying the foundation of rational forest management, and that it is necessary to organise everything in as simple and plain a manner as possible. In the formation of compartments in these hill forests, the first point to be considered is the selection of natural lines or permanent paths as boundaries, and artificial boundaries should as much as possible be avoided. In the second place, the conditions of growth should be considered; these should, to some extent, be similar over the whole area included in one compartment.

The character of the actual forest growth on the ground should only be considered in the third place; and this consideration will regulate the formation of compartments only in exceptional cases, such as where the higher part of a ridge is covered with Kharsu, and is thus naturally separated from the lower portion.

The descriptive accounts of compartments may be simplified by combining several of the sub-heads prescribed in paragraph 79 of the Code; thus, "configuration of the ground," "aspect" and "gradient" may be combined in one; and similarly everything that relates to the growing stock may form one head, whilst the last head may be made to comprise past management, present condition, and proposals for future treatment.

For some time to come, it will not be practicable to find much time for going on with these descriptive accounts. Those already drawn up should be revised as opportunity may occur. The work is not of pressing importance.

Valuation surveys.

72. Nor do I consider that at the present time a valuation of the growing stock in the different blocks of the Báwar and Deoban ranges is as urgent as the other work indicated in the preceding pages. It would undoubtedly be very satisfactory to regulate our cuttings by an accurate knowledge of the growing stock; but it is of far greater importance that when cuttings are made in any locality, these cuttings shall be so arranged as to secure complete and rapid reproduction of the forest, be it by natural or by artificial means. In the Báwar range the time for extensive cuttings has not yet come, and in the Deoban range the general arrangement of cuttings is of necessity regulated by the area which we have been able to close against grazing and by the growing stock available for cutting. Those branches of the work which have as their aim the protection, improvement, and reproduction of the forest will, for several years to come, claim the entire attention of the Range officer, and it will probably not be found practicable to make the valuation surveys which are required in order to obtain a correct knowledge of the growing stock. However, in case additional help should be obtained by the appointment of probationers or otherwise, it will be a good plan to collect data regarding the stock of different classes of trees growing in any block in which fresh cuttings are proposed to be made.

Matters to be studied in Deoban range.

73. The officer in charge of the Deoban range should use every opportunity he may have of studying the rate of growth under different circumstances of the trees which compose the forests of that range. Arrangements should also be made as soon as possible to determine the reducing factor of the different kinds of trees grown under different circumstances, and it is necessary without delay to take steps for determining the relation between solid and stacked fuel.

The greatest care should be taken to keep a perfect and detailed record of the yield in wood of each block and compartment, and this record should exhibit separately dry and green wood.

It will also be necessary to maintain a complete record of all planting operations and of all facts which are of importance in regard to forest management. It will readily be understood that present circumstances in the Deoban range are peculiar. Experience has shown that cuttings are not safe as regards reproduction where sheep and goats are admitted. Consequently, the great work to be accomplished is to effect the closing of a sufficient area to provide the annual requirements of Chakrata. The framing of a working-plan must be deferred until it is known what area can be closed. Meanwhile, however, such data as relate to the rate of growth, the reducing factor, and the relation between selected and stacked fuel, must be collected.

Again, in the Báwar range, cuttings, except on a small scale, are not required now, and the preparation of working-plans would be premature.

CHAPTER IV.

DEHRA DÚN.

Area

74. The Dehra Dún Division comprises the forests on the northern slopes of the Siwálik hills and those in the valley of the Dún. The aggregate area amounts to 171,982 acres.

Principal trees found in the Dehra Dún Division.

75. With the exception of the low ground near the Song, Suswa and Jákhan rivers in the Eastern Dún, these forests are chiefly stocked with Sál, associated with other trees, of which the following may be noted:—

On the hills and near their base Bákli (*Anogeissus latifolia*), Dhaura (*Lagerstræmia parviflora*), and Sándan (*Ougeinia dalbergioides*) are the chief associates of Sál. Lower down on the more level ground these kinds are also found, but others are more characteristic of these localities, *viz.*, Haldir (*Adina cordifolia*), and Keim (*Nauclea parvifolia*), Aonla (*Phyllanthus Emblica*), Bahera (*Terminalia bellerica*), Kakar (*Garuga pinnata*), Bhiláwa (*Semecarpus Anacardium*), Piáman (*Eugenia operculata*), Siris (*Albizzia odoratissima*), Pipal (*Ficus religiosa*), Bargat (*Ficus bengalensis*), Dháman (*Grewia vestita*), Kachnár (*Bauhinia variegata*). On stiff clayey soil Sain (*Terminalia tomentosa*), and near streams Jáman (*Eugenia Jambolana*) are common. Bamboo (*Dendrocalamus strictus*) is rare in the Dehra Dún forests, and it is chiefly found on the north slope of the Siwáliks in the Eastern Dún.

The ridges and higher spurs of the Siwáliks are without Sál. Here the chief trees are Sáler (*Boswellia thurifera*) and Khat Bhiláwa (*Buchanania latifolia*), which form an open and almost useless forest. On the low ground in the Dún, along the banks of the rivers and on islands, the forest contains Khair (*Acacia Catechu*) and Sissoo (*Dalbergia Sissoo*). Besides these descriptions of forests there are large extents of mixed forest without Sál in the level portion of the Dún, in which the same trees are found which are associated with Sál below the hills; and in addition to them Dún Siris (*Albizzia procera*), Khair (*Albizzia stipulata*), and Chilla (*Casearia tomentosa*) are found.

Fire-protection

76. The chief work in the Dehra Dún forests during the next few years will be the fire protection of Bulawála and the adjoining forests, of the Tháno forest, and of the Khair and Sissoo forests between the Jákhan and Suswa. Regarding Tháno nothing need be said here at present.

The Bulawála block, which has an area of 7,680 acres, is at present protected from fire, and it appears best that the extensions should all at present be made on the western side, so as to place the whole area between Bulawála and Assarori under protection as soon as possible. The next extension to the west will be called the Balindawála block.

System of fire lines.

77. Within the area of this extension it will be best to continue the horizontal lines on the present system, *viz.*, a lower line, a middle line, and, as far as the ground permits, an upper line, each cleared to a width of 60 feet, the grass on them being burnt annually between two six-foot paths cleared at the edges. Wherever the upper and lower lines have Government forests on both sides of

them, the grass on the outside of these lines should be burnt for a considerable distance; this will serve as an additional safeguard. The cross-lines in the extension should, however, not be straight 60 foot lines, as in the portion already protected, but they should be arranged partly to facilitate fire-protection and partly to facilitate the export of timber. Instead of broad cleared cross-lines I propose to lay out a system of fair-weather cart-roads running across the horizontal lines, but following the configuration of the ground. These roads need not have a width of more than 10 feet, and parallel with them the grass will be cut on two narrow paths, leaving two belts on either side of the road, about 25 feet wide, which are to be burnt off in the hot season. These roads cannot be straight, nor can they be at uniform distances apart; but the average distance may be about half a mile. Experience must show whether it will not suffice to have them at a greater distance apart. They should extend from the upper line down to the cart-tract from Bulawála to Assarori; and this cart-track should be improved so as to induce exporters to use it for the export of wood cut on the lines and any other wood that may be available. These transverse roads being narrow, will be shady, and the shade will facilitate their being kept clear of grass. They will probably be found quite as efficient for fire-protection as the present broad cleared cross-lines, provided the leaves which fall during the dry season are swept up and burnt periodically; and they will also be found useful for inspection and for the export of forest produce, for which purposes the present broad straight lines are perfectly useless. As far as practicable, all stumps on these transverse roads should be removed; the ground should be levelled and shallow ditches should be dug on either side of them. They will not, it is true, divide the forest into rectilinear compartments, but in broken and undulating ground like that of the Dehra Dún this is neither practicable nor necessary.

Fire-lines and roads to be named, and compartments to be numbered.

78. In order to facilitate the record of the success or failure of fire-protection and the management of the fire-protected forests generally, it will be necessary to designate each transverse road by a name, and to denote each compartment formed by the horizontal and cross roads by a number. Names should also be given to the cleared 60-foot horizontal lines. The numbers of compartments should run from east to west.

Thinning and creeper-cutting at Bulawála.

79. During 1876, 1877 and 1878, 1,920 acres of Bulawála were thinned out. The compartments in which these thinnings were made form a continuous series between the lower and middle lines in the western half of the lower range of compartments. They are separated by the middle line from an equal number of compartments of equal extent, which are untouched, and thus afford a ready means of comparison between the growth of the compartments thinned and those left untouched. The trees cut out were marked and the stumps of the Sál trees of all sizes were counted, and the result is reported to have been an average of about 21 Sál trees cut per acre. I examined the thinnings of the three years, and have come to the conclusion that far more Sál trees were cut out than is good for the development of the forest. The proper course would have been to cut out spreading and badly-shaped trees, which, if left, would have interfered with the uniformity of the growing stock and which, in comparison with their value, took up too much ground which should be available for the young growth. Such trees have been cut out; but, in addition to them, numerous straight poles and saplings of Sál and other kinds have also been cut under the mistaken impression that the crop on the ground was too thick. The result is an open forest consisting of Sál, with a few Bákli and Dhámun. The Sál poles left standing are in most cases well-grown trees of from 70 to 80 feet high, but they are young, and many of them do not yet produce seed. Had they been allowed to remain standing in company with the poles cut out, they would have drawn each other up considerably, and would probably, when mature, have attained a height of 100 or 150 feet. Isolated as they now stand, their growth in height will be checked and they will only increase in girth; on this account the forest will be much less valuable than if it had been allowed to grow up in compact masses.

The average number of Sál poles per acre left standing is 30, while a full crop of mature Sál trees would probably consist of 100 trees per acre.

Although the earliest thinnings are only two years old, yet the ground in these thinned compartments has in many cases covered itself with a heavy crop of tall grass, and it is also covered with tops and branches of the trees felled, and in many cases with entire trees which could not be sold. It is obvious that if fire should enter any of these thinned blocks, the result would be most disastrous, and the greatest vigilance must be used to guard against the entrance of fire. The leading idea in these operations seems to have been to produce a complete and vigorous crop of young growth of Sál, and in some cases the coppice shoots of the trees cut are numerous and tall; but there is nowhere a certain prospect of the ground being covered with a complete crop of Sál. The progress of the young growth in these compartments must be carefully watched. It is possible that the abundance of light given may have the desired effect; but under the most favorable circumstances, it is certain that the value of the forest has been greatly diminished by this operation.

In the compartments left untouched, the growing stock, it is true, is very irregular. There are young trees of all ages, and a large number of small patches covered with young growth; and there are blanks which with every additional year of fire protection fill themselves more and more with seedlings and coppice shoots. I have come to the conclusion that it will at present be better to allow this irregular forest to grow up, only taking care to cut out all irregularly-shaped spreading trees. The advantage of this proceeding will be that, in those patches which are now stocked with a mass of poles, these poles will draw each other up and attain a considerable height, while at the same time the patches of young growth will grow up, occupying in the aggregate a considerable portion of the area. It is true that the character of the forest will be irregular; but considering the result as a whole, the production of timber per acre will be increased. In the thinned blocks, the sun has access to the ground, and whatever moisture is furnished by dew or rain will evaporate much more rapidly than in the forest left untouched. This remark must not be misunderstood. It is not impossible that acre for acre the quantity of water evaporated by the untouched forest is greater than the quantity evaporated in the thinned compartments; but in the former case, the greater part of the water evaporated has been taken up by the roots, has passed through the trees, and has helped to form wood; whereas, in the thinned compartments, much water is evaporated from the soil direct without having been utilized by the trees.

Again, if regard be had to the periodical supply of timber in the future, the expediency of these heavy thinnings appears doubtful. The untouched forest will yield a large quantity of marketable timber when the larger poles have attained maturity, and it will afterwards yield a regular succession of timber as the younger classes attain the same state; whereas in the thinned compartments there will be a smaller crop per acre of large timber when the poles left standing have attained maturity, and there will be a long interval without any yield until the young growth is fit for cutting. The chief drawback to the operation, as it has here been conducted, is the extreme risk of fire to which it exposes the forest, and, as already stated, the utmost care must be taken to ensure the efficient protection of these thinned compartments. If continuously protected from fire, the result of this experiment will, however, be highly instructive. The operation has been conducted on a definite plan, and on a sufficiently large scale to give a definite result by comparison with the compartments which have not been touched. Simultaneously with these thinnings, all creepers have been cut. This, and the regular distance between the trees left standing, gives the thinned compartments a neat and regular appearance, but it is much feared that, as usual, the creepers will profit by the abundance of light given them and will again spring up vigorously.

System of thinnings to be adopted in future.

80. Regarding the future, I have recommended that the following principles are to be followed in conducting the thinnings. All irregularly-shaped Sál trees which are large enough to yield marketable timber, are to be girdled by cutting a ring through the bark and sapwood into the heartwood. This operation must be complete, so as to secure the speedy death of the tree. It

will probably be possible to sell these trees standing, compartment by compartment, at profitable rates. Round adzed poles, about 12 feet long and about 6 inches in diameter (called "Tors") are in great request, if cut from dry trees, because in that case they are well seasoned and do not split; and I expect that the wood of girdled trees will be valued for the same reason. Hitherto the girdling of Sál trees has been considered a mistake, because it was supposed that the timber would be rendered useless by the borings of the carpenter bee. I had an opportunity, in Bulawala, of examining a number of dry Sál tors, and found them perforated by two kinds of insects,—one, making smaller ducts than the other, is the larva of a beetle, while the borer of the larger ducts is probably the larva of the carpenter bee (*Xylocopa*). Timber-traders, however, do not object to timber perforated by these insects, provided it is well-seasoned and does not crack or split; and under these circumstances, I have decided as an experiment to recommend the girdling of Sál trees. Several other kinds of trees, the wood of which is likely to sell, may be treated in the same manner as Sál. The chief of these are Sein, Bákli and Jáman; but it must be remembered that only trees with a distinct heartwood can be killed by girdling. Trees without a distinct heart wood, such as Haldu (*Adina cordifolia*), Keim (*Nauclea parvifolia*), which have no distinct heartwood, may be killed by stripping off a broad ring of the bark, but they are not killed immediately by this operation; and as the wood of such trees is not very durable it is better to fell them green.

As a rule, it may be said that all trees with spreading crowns which cannot be expected to form part of the final crop, and which take up too much ground and throw too much shade in proportion to their value, should be cut out. The object of this improvement felling is to give room for young thickets and saplings of Sál and to give greater regularity in the forest. It is intended to produce compact masses of trees of similar shape, but not always necessarily of the same age or size. In conducting this operation it should be borne in mind that it is by no means desired to convert these forests into pure Sál forests, but that on the contrary a mixture of other trees is considered most desirable. The experience gained in other countries abundantly shows that forests consisting exclusively of one species are exposed to risks from which mixed forests are exempt. There is no object in cutting out any slow-growing trees or shrubs; the growth of these should, on the contrary, be encouraged. In patches of mixed forest, where trees other than Sál predominate, it may occasionally be desirable to thin out the useless kinds so as to favor the growth of Sál and of some particularly useful species. The species which should be encouraged in addition to Sál are—

a.—All species of *Ficus* for cattle-fodder.

b.—Dháman (*Grewia vestita*),

c.—*Cordia vestita*,

d.—Sándan (*Ougeinia dalbergioides*),

e.—Haldu (*Adina cordifolia*),

f.—Bákli (*Anogeissus latifolia*),

g.—Daura (*Lagerstræmia parviflora*),

h.—Sain (*Terminalia tomentosa*),

and any others which it may appear desirable to encourage for special reasons. Straight trees of all kinds which form part of the principal growing crop should be left untouched; and it is not intended to cut out from a mass of poles, or a thicket of saplings, individual trees which overtop the others, provided they do not too much interfere with the growth of their neighbours. No trees whatever should be cut which stand at the edge of blanks or on the outskirts of the forest or at the edge of water-courses. It should also be borne in mind that in scarcely any part of the forest is the cover complete, and that the cutting of every tree lets in light and increases the growth of grass and the risk from fire. Every thinning, therefore, has its drawbacks, and hence the operation should be conducted most cautiously and under competent supervision. On the other hand, it is most desirable to increase the supply of

dry Sál tors, an article for which there is always a considerable demand. Simultaneously with the thinnings above suggested, all creepers should be cut in the compartment taken in hand. The work here described should not be commenced in more than one compartment at a time, and should, if possible, be completed during the season in any compartment in which it has been commenced. The trees that are felled may, if otherwise convenient and if this can be done without undue expense, be brought to the nearest cart-road by Government agency; and the experiment may be made of collecting the tops and branches and other wood, that will not pay for removal, and of converting them into charcoal.

When purchasers are admitted into the compartment to remove dry wood, their operations should not as a rule extend beyond the 15th February.

Descriptive account of compartments.

81. Of every compartment in which work is undertaken, a brief descriptive account should be drawn up, which should enumerate all extensive blanks with their areas, and give, as far as possible, a general description of the ground (mentioning raus, ravines and nature of the soil), as well as of the present character of the forest. These descriptive accounts, which will be of a summary character, in forests so uniform as those now treated of, should be entered in a book after having been countersigned by the Conservator. Space must be left at the end of the record of each compartment for the additional remarks that will be made annually. The annual entries should be made at the close of the working season, say in May or June, and they should contain an account of the produce removed and revenue realized during the financial year, as well as of the work done and expenditure incurred.

Sample plots.

82. A number of sample plots were, some years ago, demarcated and fenced in the Bulawála block. The chief object of these sample plots was to determine the rate of growth of the Sál tree in this forest under different conditions of treatment. Periodical measurements of Sál trees are useful as the counting of annual rings in the wood of Sál is difficult and uncertain. The annual measurement of the trees in these plots should be continued, and it will be best always to make them in the month of March. A mark should be painted and a nail driven in, and the measurement should be made 6 inches above and 6 inches below the nail. Great care must be taken always to measure each tree at the same points. Stems which have excrescences or are irregularly shaped should not be measured. As the trees marked for measurement are all of about the same size, it will be sufficient to measure 25 trees in the plots left untouched, and the same number in those plots where heavy thinnings have been made. A full record of these measurements, with a descriptive account of each sample plot, should be recorded in a separate book. The descriptive account should state the number of trees on each plot, the nature of the cover, and the general character of the forest, and any changes noticed should be recorded annually.

This book should be designated—"Record of experimental sample plots."

Plantations.

83. I examined the plantation at Bulawála, which was made in July 1874. Sál seed was here sown in plots about 6 feet apart in about an acre of open grass land included in the fire-protected compartments. Many plots have failed, but the plants which have survived are strong, about 12 inches to 18 inches high, and have roots much thicker, longer, and more vigorous than the roots of natural seedlings of the same age in the forest. This, however, may be entirely due to the deep and good soil in which they are growing. These plants had died down every year to the root in the same way as the natural seedlings in the forests; and, accordingly, at the head of each root are visible the remains of successive shoots killed down annually from the year in which the plants germinated. The shoots above ground do not in this plantation consist only of the growth of 1878, but the growth of the last two years, 1877 and 1878, can be distinctly recognized. This was not the case in any of the seedlings in the mature forest that had sprung up since fire-protection had been commenced; these having died down to the root every year. The plants raised in this plantation had numerous lateral buds at the base of the stem ready to shoot forth whenever the stem above ground had been killed.

The development of Sál seedlings should be carefully studied in all plantations that may be made in the Dún. We know that as a rule during the first years of its growth the shoot of every Sál seedling dies down to the ground annually, and this generally happens during the hot season, but it may occasionally be caused by the frost of winter. The effects of frost and the heat of the hot season upon Sál seedlings should be studied. I have recommended that every year a certain area of open grass land on the edge of the forest should as an experiment be sown with Sál. The seed should be sown in patches as was done in 1874; but these patches should in future be arranged in parallel lines, the distance between the lines being about 20 feet, and the patches within the lines being close together, their distance being regulated by circumstances. Nurseries of Sál should be made in the forest garden at Dehra, and experiments should be tried in the transplanting of Sál. This operation is believed to have succeeded in Gorakhpur. I may add that the transplanting of natural seedlings of Sál from the forest has been most successful in the Buxa Forest, Western Dúars, and it should have a trial in the Dún.

At present, however, the cultivation of Sál in the Dún must be regarded rather as the means of gaining experience on the subject than as an attempt to stock extensive blanks. For cultivation of Sál on a large scale in the Dún we have neither money nor time to spare at present and it is not a work of urgent necessity. It appears preferable to concentrate our attention mainly upon the measures which will ensure the regeneration of the forest by natural means, and its improvement by the thinnings here suggested. The experimental Sál plantations should be as near the residence of the Ranger as possible, and in the vicinity of the compartment where girdling and thinning are going on. As a matter of course, a complete and detailed record of this experimental cultivation should be kept in the manner prescribed by the Forest Department Code.

Communications.

84. The area of Government Forest at our disposal in the Dún and Saháranpur districts is very extensive, and the present export of wood and forest produce from these areas is small. It certainly is necessary to stimulate export as much as possible. If the areas were limited, a rigidly conservative plan of working would be imperative; but with so large an area at our disposal we shall be justified in somewhat relaxing conservative principles whenever this may be necessary. The chief measure to be taken in order to increase export is to open up a larger portion of the forest area by good cart-roads. I have recommended that two lines of cart-road proceeding from Assarori on the Mohan Pass road should be opened out and improved; one running in an easterly direction through the Motronwála, Balindawála, and Bulawála Forests; and the other in a westerly direction, following as far as practicable the line of the elephant track. The forests along the eastern road are protected from fire, or will soon be so; and all the cross-roads proposed to be made to facilitate fire-protection will serve as feeders. Along the western road no fire-protection has yet been commenced; but it is for consideration whether this portion should not be taken in hand after fire-conservancy from Assarori to Bulawála has been fully established.

These two main lines of road will serve chiefly to facilitate the export of dry timber, and the supply of this material should increase by judicious girdling operations, which, as already explained, should be confined to the blocks protected from fire. What is desired is to induce the inhabitants of villages in the plains outside the Siwáliks to come up with their carts, during the slack season, for wood and other forest produce, and thus to increase competition among exporters of wood from the Dún.

A third line of road should be laid through the Lachiwála Forest from a convenient point on the Hardwár road to Bulawála. This line also should be made practicable for carts, so as to give another outlet for the dry wood of the Lachiwala Forest, and to make certain portions of Bulawála more accessible.

An objection may be raised to this idea of opening out the forests by means of cart-roads, *viz.*, that the custom of the country is to drag the timber and not to cart it. Very likely some of these roads will at first be used for dragging, but eventually the use of carts will gain the day. After the success

of these lines of road has been established, it should be considered whether the Ambári Forest should not be opened up by a road which would serve as a feeder to the Timli Pass and Dehra Dún roads.

Huts and wells.

85. Every effort should be made to economise the time of the superior and subordinate officers in charge of these forests. The roads already proposed will aid considerably in this respect. In addition to roads, wells and huts for shelter should be made in convenient places, and particularly where any work of importance is progressing.

It has been found in the Oudh forests that the making of good wells in all parts of the forest and a regular and well-planned system of roads has considerably increased the export of dry timber; and the same will doubtless be the case in the Dún.

Work done at Bulawála

86. The following is a summary of the work done up to date in the Bulawála block.

Fire-protection.—Work was commenced in this forest in 1872, when an area of about 245 acres in compartment 15 was protected. In 1873 an additional area of 61 acres in the same block was protected, raising the total area to 306 acres. In 1874 the remainder of compartment 15 was taken in hand, and compartments 7, 8, 9, 10, 11, 12, 13, 14, 16, 17 and 18, each of about half a square mile, were formed, the protected area being then 6 square miles (3,840 acres). In 1875 the remainder of the compartments, *viz.*, 1, 2, 3, 4, 5, 6, 19, 20, 21, 22, 23 and 24, were taken in hand, and since then the whole forest, 12 square miles (7,680 acres), has been under protection.

The cost of these operations has been as follows :—

1872	...	245 acres	.. No information.
1873	..	306 „	... Rs 405
1874	..	3,840 „	. „ 753
1875	..	7,680 „	„ 2,112
1876		7,680 „	. „ 448
1877	...	... 7,680 „	„ 999
		Total cost	... Rs 4,716

Fires.—The forest was successfully protected against fire until April 1875, when compartments 1, 2, 3, 4, 5, 6, 7, 9, 16 and 18, with a small portion of compartment 13, amounting in all to an area of 3,210 acres, were burnt; and during February 1876 compartments 1, 3, 5 and 7 (1,280 acres) were burnt. Compartments 1, 3, 5 and 7 were, therefore, burnt in two successive years. Fires have not entered the forest since February 1876.

Thinning.—Compartments 13 and 15 were thinned in 1876-77; compartments 17 and 19 in 1877-78; and compartments 21 and 23 in 1878-79, the total area thinned being 1,920 acres. The average number of Sál poles cut per acre was about 21, and the number remaining per acre is 30. The larger Sál trees were sawn into scantlings and sold, while the smaller poles were collected at depôts on the forest boundary, and the larger portion of them is still unsold. The expenditure on the thinnings of 1876-77 and 1877-78 amounted to Rs. 12,653, and the amount realised up to date is Rs. 19,929. The stock in hand is estimated to be worth Rs. 4,000, so that when all the wood is sold, the net profit will be about Rs. 11,276, or Rs. 8-13 per acre. The results of the thinnings of 1878-79 are not yet obtainable.

The sample plots and sál plantation have been described in paragraphs 5 and 6 of this report.

Requirements of the villages in the Dún.

87. The inhabitants of the villages in the neighbourhood of the Government forests in the Dehra Dún are permitted to graze their cattle in those forests, and to collect head-loads of dry fallen wood for fuel at certain fixed rates; and the rules which have now been proposed for the forests under sections 25 and 75 of the new Forest Act provide for this grazing and collection of fuel in the whole area of Ambári, Chándpur, Dholkot, Nágsidh (including Lachiwála), a part of the Song forest, a part of Tháno, and in a portion of the Western Siwálik forest. It is not necessary to discuss here whether this grazing

and collection of fuel is pursued by virtue of a right. It is sufficient to state that the requirements of the people in this respect should be met in the manner most convenient to them and with the least possible interference with the conservancy and improvement of the forests.

The orders of the Government of the North-Western Provinces, of the 18th February 1875, are to the effect that the forests on the northern slope of the Siwáliks in the Eastern Dún are to be closed, and that no grazing rights exist in them. The greater part of the Tháno forest, the Sál forest between ths Jákhan and Ganges, commonly known as the Tirsál, and the Khair forest along the Song, Jákhan and Suswa, are also to be closed. As regards the forests on the northern slope of the Siwáliks in the Western Dún, it was arranged that blocks should be marked off sufficient for the grazing needs of the neighbouring villages and left as open forest, the remainder being closed.

It was then intended that the open and closed portions in the Western Siwáliks should be in alternate blocks, and a commencement has been made to demarcate the blocks by lines marked out on the ground. The arrangement, however, proposed in the rules above alluded to is a far preferable one. By it any portions of the forest up to one-half of its total area may be closed, provided that the portions left for grazing and the collection of fuel are situated conveniently for the villagers.

As already explained, it is not intended immediately to extend fire-protection beyond the Eastern Siwálik forest, the Tháno forest, and the Khair forests of the Jákhan and Suswa, but when the time comes to extend the work to the Western Siwáliks, it seems to me that what should be done should be to close those portions which, as a matter of fact, are not regularly grazed over. In this manner it may be possible to protect a considerable belt of Sál forest situated at the foot of the Siwáliks. I propose that for the present a similar plan should be followed in the Balindawála and the Motronwála forests of the Eastern Siwáliks adjoining the villages on the Suswa. Here also a belt near the village is grazed over regularly, while the inner belt nearer the hills is untouched, and may be protected. If the principle here explained is followed, *viz.*, of leaving open those portions of the forests which are grazed over regularly, it may perhaps be possible a few years hence to close that portion of the Lachiwála forest which lies at the foot of the Nágsidh hill, and possibly a portion of Ambári and Dholkot in a similar manner. At present, at least, grazing and fire-protection in the same forest must be considered incompatible; but it may be hoped that eventually, when the people are more accustomed to fire conservancy, it will be possible to protect some of the forests in which grazing is permitted.

88. The grazing dues in the Dehra Dún Division (including Saháranpur) have realised the following amounts during the past eight years :— Grazing dues and grass.

	Rs.
1870-71	7,527
1871-72	8,810
1872-73	5,832
1873-74	8,501
1874-75	7,189
1875-76	8,146
1876-77	3,260
1877-78	24,958

The large realisations in 1877-78 are due to the drought, which induced large herds of cattle to come up to the Dún from the plains.

There may be some decrease in this branch of revenue on account of the diminished area available for the grazing of cattle from outside the Dún, in consequence of the extension of fire conservancy; but the loss in this respect will be more than made up by the increase in revenue derivable from other sources in the protected blocks, in which, as explained above, a certain amount of felling may take place; while in the forests which the grazing requirements

of the inhabitants render it necessary to leave in their present state, no felling of green timber can be permitted.

There should be no decrease in the revenue on munj, bínd, and pula grass. These items have yielded as follows:—

	Rs.
1871-72	4,955
1872-73	4,200
1873-74	2,585
1874-75	4,731
1875-76	4,636
1876-77	4,728
1877-78	3,147

Khair and Sissoo forests.

89. The tracts along the Song and Suswa, and between the former river and the Jákhan rau, are the principal sources from which the pestles of Khair wood used for sugar and oil mills (called "churans") are obtained. The export of these is considerable. In 1874 they were paid for at the rate of Rs. 13 a score cut and collected by the purchaser; the price is now Rs. 18 a score. The following amounts were realised by their sale in the Dehra Dún Division during the last six years:—

	Rs.
1872-73	5,337
1873-74	5,250
1874-75	10,020
1875-76	1,952
1876-77	3,326
1877-78	441

This means that, on an average, about 4,400 trees a year have been cut; and as the lower part of the tree is dug up, there are no coppice shoots, and moreover the annual burning of the high grass between the trees entirely prevents the growth of seedlings.

The following is an extract from a report of 31st March 1870, by Dr. King, written while in charge of the Dehra Dún forests: "Prior to 1860 churans brought from Re. 1 to Re. 1-12 per score; in 1860 the price was raised to Rs. 3, and now Rs. 7-8 and Rs. 8 are the common rates." The rates paid to Government have now been raised to Rs. 18 per score, and with increased sugarcane production in the Upper Doab, the demand for Khair churans is likely to grow so much, that a higher rate might safely be charged. The chief difficulty probably is, that the supply is diminishing. On private lands purchasers pay Rs. 10 to Rs. 14 only; but the supply of large trees from private estates is said to be insignificant. It is a matter of great importance to obtain complete control over Khair-producing tracts of sufficient extent to furnish a good supply of this article, and no better soil and otherwise more favourable conditions could be found than in the Khair-producing tracts between the Suswa and Jákhan rivers. Some of these Khair-producing tracts may be liable to be swept away by changes in the course of the rivers, but the greater part of them will probably be found to be of a permanent nature. The first point to consider is, to determine and demarcate the area which may be protected against fire and cattle in this part of the Dún forests. The next point will be to clear a system of fire-lines which in this open forest will neither be difficult nor expensive. Fire once kept out, a dense growth of Khair will spring up, similar to some patches which are seen on islands in the Song river and its feeders, but with this difference, that part of the land will be permanent. A number of shading trees and large shrubs, such as *Ægle Marmelos*, *Murraya exotica*, *Casearia tomentosa*, are commonly found associated with Khair in these localities, and this mixture should be encouraged. Khair should not grow up pure, but rather mixed with other kinds.

The existing belts of Sissoo, many of very good growth, in this tract will add to its value. Some of the groups of Sissoo poles on the branches of the Song river have unusually straight and tall stems. As soon as these Khair

and Sissoo forests, which it is proposed to place under special protection, have been selected, a complete system of fire-lines should be cut through them and fire conservancy should be commenced. On the success of this work the prospect of a continued supply of Khair churans from the Dún depends. Eventually this will be the place for Khair and Sissoo plantations, but these must wait until matters are sufficiently advanced to justify the appointment of a Forest Ranger to the executive charge of this portion of the Dún forests. The fire-lines should, as far as possible, be suitable to be used as export roads. It will not in all cases be possible to make them straight.

Future yield of the Dún forests.

90. It has frequently been asserted that the Dún forests never will yield large timber. Even supposing that this were the case, a large portion of the crop at present on the ground would find a market; but there is no reason whatever to doubt that the poles of 60 to 90 feet high, and of 2 to 5 feet in girth, of which we find large masses on the better soil of almost all the Dún forests, will attain a girth of 6 feet with a good length of bole; and both the stumps remaining in the forest and the beams in the houses at Dehra conclusively show that considerable quantities of large timber were formerly produced in the Dún. From a report dated 14th May 1872, by Captain Bailey, when in charge of the Dún forests, it appears that the right of collecting revenue on the export of timber was leased from 1839 to 1844 for Rs. 33,500 a year. The lease was discontinued in 1844, as the Superintendent of the Dún had ascertained that the holder was receiving about Rs. 80,000 a year by the duty on exported timber, and from that time until 1855 the collection of the duty realised from Rs. 80,000 to Rs. 1,00,000 annually. Considering the small value of timber in those days, and that small timber was not exported, a conclusion may be formed as to the large quantity of timber that was cut at that time.

It is questionable whether hereafter it will be expedient to adopt, for these forests, as long a rotation as is undoubtedly indicated for the forests of the Pátli Dún, and for some other forests of Garhwál and Kumaun. Considering the vicinity of the Dún to the plains, and the demand for poles, rafters, (karries), and other small timber, it will probably be most profitable to cut these forests as soon as the trees have attained a girth of 5 or 6 feet, and thus to work them on a short rotation, provided that trees of that size yield a full crop of seed. This, however, is a question which our successors must consider, and which can hardly be decided without the experience of a generation regarding the growth of Sál when protected from fire in these forests.

Every effort must now be made to realise as large a revenue from these forests as is compatible with their maintenance and improvement. Dry Sál timber removed by purchasers will probably be the most important item, and every effort should be made to make large quantities available annually by girdling old Sál trees in the fire-protected blocks. Every opportunity that may offer for the sale of timber of other kinds should be taken advantage of, and the export of timber should be facilitated by opening out a system of roads, and by thus laying out the system of fire-lines that as many of these lines as possible may be used for the export of timber. Fortunately the area of the Government forests in the Dehra Dún is large; their present yield is insignificant, and under proper arrangements they might be made to yield much larger quantities and a much larger revenue than they furnish at present.

Note.—The following trees were measured as samples of average growth in the Bulawála and adjoining forests:—

Girth.		Height.
Feet.	Inches.	Feet.
5	1	84
4	0	81
3	6	81
5	0	85
2	3	60
3	7	76
4	3	82
3	3	71
3	0	72

CHAPTER V.

SAHÁRANPUR.

Sub-division into two ranges.

91. The Saháranpur Division may for the present be sub-divided into two ranges, *viz.*, the Western and the Eastern range.

Western range.

92. The Western range includes all the forest land from the Saháranpur and Dehra Dún road (*viâ* the Mohan pass) to the Jumna, and up to the water-shed of the Siwáliks. Its area is 79,971 acres, the greater part of which is in the hills. There is generally a strip of flat ground lying between the southern boundary-line and the foot of the hills, which at present does not contain timber of much value, though there is a patch of small-sized Sál at its eastern extremity west of the Khajnaor Rau. The slopes of the hills within the Siwáliks are mostly covered with babar grass (*Andropogon involutus*) and a sedge (*Eriophorum comorum*), often erroneously called babar. These hills also bear a light crop of trees, principally Bákli, Daura and Chir, while some of the moister valleys contain Sál and bamboos with other species. Some of the Chir and Bákli are of fair size, but generally speaking the whole forest in the Siwáliks is extremely poor. A great deal of firewood might be taken out, if it could be sold, and although there is probably no portion of the range in which the felling of green timber is in itself desirable for the improvement of the forest, it will be necessary to keep up and stimulate the demand for forest produce by allowing the cutting of a certain amount of green timber annually, if it can be disposed of at profitable rates.

System of collecting revenue.

93. The revenue on bamboos, firewood, charcoal, and minor forest produce is realised either by passes taken out by exporters at the head office, or by tickets issued at the line of chaukis along or near the sub-montane road, or by leases. The system of leasing to contractors the collection of revenue on all minor forest produce, which has been adopted in part of the forest for the last few years, may be continued for the present in a portion of the range; and for this purpose the range should be sub-divided into blocks extending from the water-shed of one main "Rau" to that of the next, and so on. The boundaries of the blocks thus formed must be entered on the maps, and a brief descriptive account of each block should be made.

System of leasing the revenue on minor forest produce to contractors.

94. Whenever the system of leasing is adopted, each block should be leased separately, and as far as practicable, the whole of the minor produce in each should be taken by one man. By this arrangement the market value of each block will soon become known, and one man can be held responsible that no produce is removed which is not included in the lease, and that no damage is done to the forest. The leasing of a series of contiguous blocks to one man is not recommended, as the power thus given to him might be used to the inconvenience of the inhabitants of the country bordering the forests, to whom it is intended to continue the privilege of collecting (on payment) the forest produce that they require for their houses and fields. The leases should not extend beyond the period included between the 1st October and the 31st May in each year.

Leasing of the revenue on cart-loads of fuel, bamboos, and charcoal.

95. In 1872 an attempt was made to include the collection of revenue on cart-loads of dry fuel in the leases, but it was found that this system led to abuses and it was discontinued; but, now that the Saháranpur forests have been formed into a separate division, and it will be possible to exercise a closer supervision, the experiment may be tried again of leasing to the contractor the right to collect revenue on cart-loads of dry fuel. This should be permitted in one block only at a time.

The bamboos are very much scattered, and the right of exporting cart-loads of them may be included in the leases, one block at a time; this block being the same which is opened for the export of cart-loads of dry fuel. The block in which the right of collecting revenue on cart-loads of fuel and bamboos is first leased should be conveniently situated for close supervision, and the line of export should pass by one of the chaukis, at which a careful record should be kept of the number of cart-loads exported. Although it has been

recommended that the right of exporting dry firewood and bamboos should be leased from one block only at a time, this is not intended to interfere with the existing custom of the inhabitants of the neighbouring villages removing, for their own use, head-loads of dry fallen wood and of bamboos from any part of the range; but head-loads only should be so removed, and the right of collecting revenue on them may be sold to the contractors, every precaution being taken to preclude the possibility of hardship to the people ensuing thereby. Passes for the export of cart-loads of fuel and bamboos should be issued at the head office for use only in those blocks which are not leased.

Charcoal obviously cannot be included in the leases on the same terms as the other produce, because there is practically no limit to the amount which might be exported. For the present, therefore, the export of charcoal can only be permitted by means of passes paid for at the head office, or in head-loads paid for at the chaukis by the inhabitants of the neighbouring villages; but the experiment might be made of selecting and roughly demarcating compartments of the better-stocked forest in the inner valleys, and of selling the entire crop of one compartment to one man for charcoal, on condition that a certain number of groups of trees and saplings be left standing to secure reproduction. On ridges and dry hill-sides no cutting of wood for charcoal should on any account be permitted.

Objects for the maintenance of the existing chaukis.

96. The present stations (chaukis) must be maintained, whether the forest blocks are leased or otherwise. They are required—

1*st*—to guard the forests;

2*nd*—to collect revenue on charcoal and on firewood and bamboos, when these are not included in the contractor's leases;

3*rd*—to check the contractors, and to prevent them from exporting articles not included in their leases;

4*th*—to collect revenue, in the unleased blocks and in the leased blocks, during the season of the year when the leases are not in force.

These suggestions are offered as a temporary arrangement. A really satisfactory system of levying revenue from these forests has not yet been discovered. It has already been mentioned that certain produce is removed by the issue of tickets. In the Central Provinces this system has been brought to great perfection, tickets of different colors representing certain money values, and entitling the holder to the removal of certain quantities of forest produce. This system should be carefully studied, and an endeavour should be made to utilise the experience gained in this respect in the Central Provinces for the working of these forests.

Eastern range.

97. The eastern range includes the whole of the forest land east of the Mohan Pass road and up to the water-shed of the Siwáliks. Its area is 91,082 acres. The character of the hill portion is similar to that of the greater part of the western range, but it contains more bamboos towards the east. The system of management recommended is the same as that to be pursued in the western range. I understand that some native timber merchants have lately offered to purchase large quantities (450 scores) of Chir and Bákli karries from the Saháranpur forests, mainly from this range. It is of the greatest importance to stimulate the export of timber and such demands should be complied with as far as possible. I do not, however, recommend that the merchants be permitted to remove this quantity as one transaction. It will be better to let them have a smaller quantity at first as an experiment, and to confine their operations to one block, which should be conveniently situated as near as possible to the Lakarkot forest, so that they may be closely supervised. After some experience as to the rates obtainable and the working of the system, a further supply might be granted. The merchants should be bound down by an agreement not to damage the forests; not to export bamboos, charcoal, or any other produce which is not included in their lease; to clear out their wood by the 1st May, and to pass it all through some named

chauki. They should pay down at least one-half of the purchase-money before commencing to cut, and the remainder when they have exported one-half. They should be bound not to cut wastefully.

The lower portion of the eastern range consists of flat ground near the base of the hills and, more to the south of a number of low ridges, the valleys between which are either cultivated, or are partly covered with an open jungle of Ber, Khair, Bel, Aonla and other kinds of trees. In the north-western part of the lower portion of the range there are some considerable patches of Sál poles. These will become very valuable for building native houses, and any other wood which can be grown in the southern portion of the range will probably find a market as fuel in Roorkee. Fuel is now taken from here to Roorkee.

Lakarkot Sál Forest.

98. The first step that should be taken is, to protect from fire the Lakarkot Sál forest which is situated on the flat ground on both sides of the Bulawála pass road. The boundaries of this forest may be laid down as follows. On the north-west the Andheri Rau; on the south-east a straight line cut by Mr. O.Greig, and two lines which must be cut through the forest, one at the foot of the hills and the other near the lower limit of the Sál.

The area of the forest will be about 4,500 acres. The outer cut lines should be completely cleared to a width of 60 feet, as has hitherto been customary in Dehra Dún. Some interior lines cut by Mr. O. Greig will probably be found and these should be utilised. If additional interior lines are required, they need not be straight and should not be completely cleared, but should be laid so as to serve as convenient export roads in the manner suggested for the transverse lines in the forest between Bulawála and Assarori (Dehra Dún).

Simultaneously with the fire-protection of this Sál forest, creepers should be cut in it and all old spreading trees that are likely to be sold should be felled or girdled according to circumstances. The principles laid down for the arrangement of similar operations in the Eastern Siwálik Forests of the Dehra Dún should be adhered to.

Bamboo forest.

99. The bamboo forest at the foot of the hills to the east of the Chirak Rau should be divided into about 10 blocks by fire-lines, a brief descriptive account of each block being made. The soil is good, and if fires can be kept out and the cutting can be regulated, there is little doubt that good bamboos will be produced. The position is very favourable, being near the Ganges Canal, the River Ganges, and the towns of Hardwár, Kankhal, and Jowálapur. To begin with one block only should be opened at a time, and the whole thinning of bamboos in this block should be sold standing to one man, under certain conditions as to the extent to which he may thin out, and as to whether he may or may not cut stems of less than one year's growth. Thinning should not be carried so far as to weaken the clumps, and after one block has been worked, several years should be allowed to elapse before it is again thinned. Experience must show what the period of rest must be, and this will determine the proportion of blocks that may ultimately be opened at one time for cutting. It is believed that in this forest a bamboo takes generally two years to harden completely.

Plantations.

100. After a few years it will be seen how far the growth of Sál is likely to be extended naturally, or whether cultivation must be resorted to. As a preliminary experiment, some Sál may be sown in open plots in Lakarkot in the manner adopted in Bulawála.

Those portions of this forest which do not grow Sál will doubtless grow Khair and Ber and some other kinds of trees. The growth of all kinds should be encouraged, and none of the existing vegetation should be removed at present. Some experience has already been gained in the artificial cultivation of Khair, Sissoo and Toon, a small plantation of four acres having been made in a piece of moist ground at Shámansúr. One piece of this plantation was ploughed up and sown broadcast. Here Khair, with a small proportion of Toon and Sissoo, has come up very well, the plants sown in July last being now on an average 6 inches high. In an adjoining plot patches were dug up

at 6 feet apart. Here Khair has come up, but is not so vigorous as that in the plot sown broadcast. This plantation should be carefully protected from fire. The soil is excellent, and the area might easily be extended, but it will be better to wait one or two years to see whether it is sufficiently safe from floods to warrant such an extension. Whenever it is extended, one-half of the ground should be ploughed and sown broadcast, and in the other half narrow lines, about 10 feet apart, should be ploughed up and the seed sown in them. Besides floods, frost will be found the great difficulty in this plantation. Against frost the best protection will be to preserve all weeds and grass which are on the ground.

Majhára Forest.

101. The islands in the Ganges known as the Majhára forest, area 4,313 acres, contain a small quantity of Khair and Sissoo, but no remarks are at present called for regarding them.

Grazing.

102. The inhabitants of the neighbouring villages are permitted to graze their cattle, on payment, in the Government forests of Saháranpur, and it is not intended to interfere with this custom. During certain seasons in the year, a considerable number of cattle from other places have also been grazed in these forests. The tracts proposed to be protected from fire must, however, be closed against cattle, but their extent is small and the measures now proposed are not likely to cause any inconvenience or loss of grazing revenue. If the localities are carefully selected it will no doubt be possible to largely extend the area protected without causing hardship to the people or loss of revenue to Government. There will be no difficulty in providing grazing for large numbers of cattle in the inner valleys of the Siwáliks, which contain abundant water throughout the year. In order effectually to keep cattle out of the fire-protected blocks in the vicinity of the open country, it may be necessary to erect rough stone walls or other fences on the exterior boundary-lines.

Principal work to be done in the Saháranpur Division.

103. The main work in this division will therefore be—

1.—The development of the export of wood by permitting the cutting of green timber in certain fixed localities.

2.—The development of the trade in other forest produce by a system of leases.

3.—The improvement of the system of issuing tickets at the chaukís for forest produce.

4.—The fire-protection of the Lakarkot Sál forest.

5.—The fire-protection of the bamboo forest east of the Chirak Rau.

6.—The protection of the plantation at Shámansúr.

Appendix A.

DESCRIPTION OF COMPARTMENTS.

1.—DEOTA FOREST.

BLOCK VIII (PATÁNGNI).

Compartment No. 2.

Area and locality.

Area 90 *acres.*—Comprises the basin which lies between the upper part of Kángadhár, and the ridge which divides the two main feeders of the Kángagád; is bounded on the west by Lambátách ridge, and drained by the northern of the two main feeders of the Kángagád; its highest point is on the Lambátách ridge, and is about 9,000 feet; its lowest point is below the two main feeders of the Kángagád at an elevation of 6,000 feet. The distance from the Lambatách ridge to the junction of the two main feeders of the Kángagád is about 1,000 yards, and the drop in height is about 3,000 feet. This at once shows that the ground is precipitous.

Configuration, aspect, and gradient.

Rock and soil.

The greater part of the area is occupied by rocky precipitous slopes with a gradient of about 45°; between these are a number of gullies and slopes with a less gradient, but there are no continuous slopes of any extent with a gradient of less than 35°; some slopes with an easier gradient are found in the south-east corner above Kimári path. The aspect on the right bank of the streams which drain this basin is more or less northerly, while on the left bank of the valley it is southerly. The rock is gneiss and mica schist, and the soil a red light sandy loam. On the steep rocky slopes there is little vegetable mould; this is evidently due to fires which used to pass regularly through these parts of the forest, and it may be confidently expected that an increase of mould will follow their exclusion. In the valley and on easier slopes the soil is black with vegetable mould.

Growing stock.

Deodar is the chief tree, but it is mixed with a few Kharsu near the ridge, and Spruce is scattered all through the compartment, particularly in moist places. Moru is found in the lower portion. Dense undergrowth of ringáls, indigo and willows occur here and there.

Management.

No cuttings have been made, but an immense number of trees have fallen, and others have died and are still standing. The large number of standing and fallen dry trees is due to the effect of fire and storms. These dry trees contain a considerable quantity of sound timber. A large proportion of the large standing green trees are half burnt through at the base. The slopes with a southerly aspect are generally bare of young growth, and are clothed with a dense matting of grass; while on all slopes with a northerly aspect, and in dells and valleys, there is a good growth of young Deodar, from seedlings to well-formed poles. Protection from fire will doubtless promote reproduction of Deodar in this compartment, and no cultural operations are required. Deodar being the prevailing tree, it will be well to postpone cutting in the whole of this compartment, so as to give fire-protection time to effect the clothing of the greater part of it with young Deodar. With the exception of the gentle slopes near the junction of the two streams, the cover overhead is incomplete, and there is light enough on the ground to permit the springing up of abundant young growth of Deodar. As far as we know the compartment at present, with the exception of the small area mentioned, there is no part of it where cuttings are required in order to give light for young growth to spring up; so that on this ground fellings do not press here. On the other hand, the dead and fallen trees should be utilized, and many of the old trees which are half burnt through at the base should be felled; but the ground being difficult, it will be more economical if the dead and half-burnt trees are converted at the time when the first regular fellings can be made. These are the considerations which must be taken into account in determining the time when fellings should be made in this compartment; but, as above explained, they must be postponed for the present.

When fellings commence, it will be well to make a distinction between the steep and rocky slopes, and the dells and small valleys with a more gentle gradient. On the former it will probably be found best to leave the growing stock untouched, with the exception of very old trees injured by fire, and which can conveniently be utilized. The dells and small valleys and slopes with a gradient under 40° are generally of small extent, and here therefore it will be possible to cut out every marketable tree; the trees on the precipitous slopes in their vicinity being sufficient to ensure reproduction and sufficient shade.

2.—DEOTA FOREST.

BLOCK VI (JAURASI).

Compartment No. 5.

Area and locality. *Area* 119 *acres*.—Comprises the basin drained by the westernmost of the two main feeders of Akrotagád, below the line of Kharsu, and is bounded on the south-west by the Missindhár, and on the east by the Akrotagád.

Configuration, aspect and gradient. The elevation is between 8,500 and 6,000 feet. The ground is cut up by ravines running into the stream mentioned, and the upper and lower portions consist of rocky precipices. The remainder of the ground has a slope varying from 32° to 42°. The aspect of the slopes varies exceedingly, but the general aspect of the compartment is north-east and south.

Rock and soil. Gneiss in large bold masses, often smoothed apparently by the action of water. Soil sandy loam, very rich in vegetable mould.

Growing stock. Deodar is the principal tree with a few Rai (which are more numerous near the Kharsu line), Moru and Kharsu near the upper boundary. On most northerly slopes groups consisting chiefly of Rai are found. In the ravines Walnut, Chestnut, Mountain Birch, Elm and Maple are common. The enumeration has given 2,000 first class and 2,200 second class Deodar trees, amounting to 17 first class and 18 second class trees per acre. Besides these there are numerous poles, saplings and seedlings of all ages. The older trees attain a very large girth and a height up to 200 feet.

Management. No cuttings have been made. Fires have been through the forest from time to time, but the injury from them is less than in Patángni. A number of dead and fallen trees are found.

Cuttings may commence in this compartment as soon as otherwise convenient, and the young growth being well advanced, a large proportion of first-class trees may be cut out at the first. In arranging these cuttings the leading principle ought to be not to cut trees here and there, but to fell all or most of the marketable trees in selected places, these places being left surrounded by trees which will bear seed and give the needful shelter. The places where these cuttings are to be made should be selected on the most gentle slopes, and if possible where there is already young growth of Deodar on the ground. To what extent these cuttings should be made, and what proportion of the compartment should be cut over, must be left to the discretion of the officer in charge. The object is to secure a complete young crop of Deodar. Apart from precipitous slopes, which must be left untouched, the belts of standing forest left between the places selected for fellings must be large enough to allow for possible losses of seed-bearing trees by storms.

3.—DEOTA FOREST.

BLOCK II (PARTHIL).

Compartment No. 2.

Area and locality. *Area* 217 *acres*.—Comprised between the Deota ridge on the east and the Deota village path on the west, being bounded on the south by the outer boundary of the forest, and on the north by compartment 3 of the same block.

Configuration, aspect and gradient. Near the road the ground is precipitous, and near the ridge there is a considerable extent of gentle undulating slopes, which are bare, except in the gullies where trees ascend to the main ridge. The elevation varies from 7,700 to 8,800 feet, the mean distance from the ridge to the road being about 4,000 feet. General aspect south-west; but the slope is furrowed by numerous shallow ravines which join below the road and fall into the Bagiár stream. Consequently there is a great variety of aspects, the south side of each valley being cold and moist, while the northern slopes are warm and dry. The gradient of the middle portion of the compartment varies from 30° to 40°.

Rock and soil. The rock is gneiss. The soil is somewhat more clayey and binding than on the Kimári side of the valley, with a deep and rich layer of vegetable mould.

Growing stock. The forest consists of a mixture of Deodar, Spruce and Moru, the two latter being in about equal proportions. The Deodar consists of trees of all ages, and the enumeration, made after the fellings had been completed, has given 1,100 first class and 2,800 second class trees, which amounts to about 5 first class and 13 second class trees to the acre.

Management. Between January 1876 and December 1877 all dry trees were cut, and a selection felling of mature trees was made. In former years, fires must have been very destructive here, nearly all large trees being burnt at the base; but fire has been excluded since 1872, and grazing since 1875. In the spring of 1878 all Spruce and many Blue Pines were ringed in about half of the compartment. This operation should be completed; but no other works of improvement are at present proposed in this compartment.

4.—DEOTA FOREST.

BLOCK II (PARTHIL).

Compartment No. 3.

Area 155 *acres.*—Lies between compartments 4 and 2 on the north and south, and the Deota ridge and Deota village path on the east and west. Area and locality.

Easy slopes not much broken up by ravines, with some precipitous ground near the ridge; general aspect south-west; gradient about 20°. Configuration, aspect and gradient.

Rock gneiss. Soil deep sandy loam, with abundant vegetable mould. Rock and soil.

Deodar and Spruce in about equal proportions; the latter being in excess on level ground. Blue Pine in the upper portion. Thick undergrowth of ringál in places. Growing stock.

The enumeration made after completion of fellings has given 1,230 first class and 1,114 second class Deodar trees, which gives 8 first and 7 second class trees (total 15) per acre. Thickets of poles and young Deodar numerous.

Above the godown there are considerable blanks which are now covered with indigo (*Indigofera heterantha,*) but which will ultimately become stocked with Deodar by seed from the surrounding mature trees; but these blanks may, if otherwise convenient, be planted up.

Protection from fire and grazing have extended from the same dates as in compartment 2. In 1876 and 1877, 932 dry and 646 green trees were cut—total trees 1,578. Management.

Spruce should be ringed; otherwise, except in the blanks above the godown, no cultural operations are necessary. The ground is at present covered with the refuse from the recent fellings. Arrangements will have to be made for utilizing it as far as possible, and for clearing the ground.

5.—DEOTA FOREST.

BLOCK III (TEMPLE).

Compartment No. 1.

Area 39 *acres.*—A narrow strip extending from the Deota ridge to the Kimári path, and between Lambi Dhár and compartment 2. Area and locality.

Steep in the lower portion, and rocky in places near the ridge; in the remainder gradient about 30°. Aspect south and south-west. Configuration, aspect and gradient.

Rock gneiss. Soil deep, with abundant vegetable mould. Rock and soil.

In the lower part there is a mixed forest of Deodar, Spruce, Bán and Moru; while the upper part is nearly pure Deodar. The enumeration after completion of cuttings has given 530 first class and 550 second class Deodar; total 1,080 trees, which amount to about 13½ first class and 14 second class trees to the acre. There are a large number of poles and masses of young growth. Ringáls thick. Growing stock.

Fire and grazing excluded, as in the Parthil block. In 1877-78, 758 dry and 296 green trees (total 1,054) were cut and converted. Rai may be ringed with advantage in the upper portion, and in parts of the centre of the compartment. Refuse wood should be cleared up, and if a crop of seedlings does not appear after the next fall of seed, the blanks should be sown up by dibbling in seed in horizontal lines. Management.

6.—DEOTA FOREST.

BLOCK IV (DOPTA).

Compartment No. 1 *and No.* 3.

Area of No. 1—118 *acres; of No.* 3—38 *acres.*—Comprise the left side of the head of the Bagnár valley, and are separated by the Argattigád from the Temple block. Area and locality.

The elevation of the Deota ridge which forms its eastern boundary is about 10,300 feet, and the lowest point, at the junction of the Gadhiárgád and the Argathigád is about 8,400 feet. The width of the block is about 4,000 feet with a fall in this distance of about 1,900 feet. The Dopta block has been divided into three compartments of which Nos. 1 and 3 contain Deodar, and No. 2 Kharsu. Compartments 1 and 3 are similar, and it is convenient to include them in one description. They consist of a series of parallel, steep, rocky ridges, separated by gullies with a somewhat gentler slope, the gradient of which may be put down at from 40° to 50°. Configuration, aspect and gradient.

Rock gneiss. Soil scanty, black with vegetable mould. Rock and soil.

Growing stock.

Nearly pure Deodar, with the exception of a narrow belt near the Temple block, where the Deodar is mixed with Spruce and Silver fir. The enumeration has given the following figures :—

Compartment 1, first class Deodar 1,944, or 17 per acre.

Compartment 3, first class Deodar 776, or 20 per acre.

Compartment 1, second class Deodar 3,239, or 27 per acre.

Compartment 3, second class Deodar 1,704, or 45 per acre.

Total number of first class Deodar 2,720, or 37 per acre.

Total number of second class Deodar 4,943, or 72 per acre.

Besides the trees included in the enumeration there is a good stock of poles and young growth in places.

Management.

Fire and grazing have been kept out since 1874.

No green trees have been felled; 127 dry trees were cut up in 1878.

It will be convenient to extend the cuttings into this block, it being contiguous to the the Temple block. It will be possible to cut out all trees of 5 feet girth and upwards in the gullies; but on the rocky ridges no cuttings should be made, except of a few trees injured by fire, which would fall in a short time. All dry and fallen trees should be converted at the same time.

It is expected that in this manner about 1,000 green trees can be cut, which will yield about 15 broad-gauge sleepers each, or a total outturn of 15,000 sleepers. The dry trees may be expected to bring this figure up to 20,000 sleepers.

Appendix B.

Memorandum by Mr. L. A. W. Rind, *Assistant Conservator of Forests, on the enumeration of Deodar trees of 3 feet girth and upwards in the Deota Forest, Season* 1878.

The enumeration of the first and second class trees at Deota was made, under instructions from Mr. G. Greig, the Conservator, with the view of framing a preliminary working plan for the Deodar Forests on the Tons. It was proposed to base this working plan on the number of first and second class green trees, and to adopt an uniform annual yield by ascertaining the actual stock of mature timber in cubic feet. For this purpose the following work was put in hand in 1878 :—

(*a*) The enumeration and measurement of all first and second class Deodar trees.

(*b*) The examination of stumps to ascertain the annual rate of growth at Deota.

(*c*) The measurement of trees after they had been felled and logged to ascertain the reducing factor for Deodar trees in Deota.

For purposes of enumeration and measurement, the first and second class trees were arranged as follows :—

Limits of girth and height of the classes.		Mean.		Remarks.
Girth.	Height.	Girth.	Height.	
Ft.	Ft.	Ft. In.	Ft.	
3 to 6	Various	4 6	Various	Termed second class trees.
6 to 9	under 30	7 6	20	Termed first class trees.
6 to 9	30 to 50	7 6	40	
6 to 9	50 to 70	7 6	60	
6 to 9	over 70	7 6	80	
9 to 12	under 30	10 6	20	
9 to 12	30 to 50	10 6	40	
9 to 12	50 to 70	10 6	60	
9 to 12	over 70	10 6	80	
over 12	under 30	14 0	20	
over 12	30 to 50	14 0	40	
over 12	50 to 70	14 0	60	
over 12	over 70	14 0	80	

The girths are at four feet from the ground. The heights refer to the length of marketable stem, such as will yield logs for 10 feet sleepers, and not to the total height of the tree. As one officer only was available for this work, the progress made was very slow; and had additional officers been obtained, the cost would have been very great. An attempt was therefore made to ascertain the number of trees of each of the four girth classes by means of parties of native measurers and recorders, the result of whose work it was proposed to check by occasional re-surveys of selected compartments by the officer in charge. The average height of trees of the four girth classes was to be ascertained from the measurement of the actual height of all trees on one or more selected lines in each compartment. The best men available were selected as recorders, and they and the measurers were carefully trained by me; but after long trial the system was found to be unsatisfactory, the results being anything but reliable. The system of enumeration by tickets was first proposed in the *Indian Forester* in

July 1877 was modified by Mr. Dansey to suit his valuation of "sál" in the Mondál Forest, Garhwál and was again modified in Jaunsár to suit the valuation of Deodar. It was eventually adopted as follows :—Four colours were selected for the four girth classes, *viz.*, class 1 = white, class 2 = green, class 3 = red, and class 4 = blue. The height classes were denoted as follows on these tickets :—the lowest height class by a plain ticket, and the remaining three height class by the numbers 1, 2 and 3, respectively, printed on the tickets. Round tissue paper tickets, 2 inches diameter, prepared as above, were procured from Roorkee, fastened up in bundles of 100 each. The plan pursued in valuing a forest by the ticket system is as follows :—the officer in charge organizes each party thus :

A forester in charge of three sub-parties, each of the following strength :—

1 Forest Guard ;

3 Gaugers ;

3 Height measurers and ticketers.

To the forester he makes over a certain number of tickets very carefully counted, also the gauges, the bamboos, the paste-pots and bags (in which there are 13 pockets for the tickets, and which are slung over the gaugers' backs). The work in two or more blocks is handed over to the forester, who distributes the work in the compartment among the sub-parties. Each sub-party passes through the forest in a line of pairs, each pair consisting of a gauger and height measurer, the Forest Guard directing them. The diameter of each tree is measured with a gauge, and at the same time its height is estimated by the aid of a 20 feet bamboo placed against the trunk. On each tree so measured a ticket of the colour and number representing its girth and height class is affixed on a blaze cut to receive it. A known number of tickets is issued by the forester for use in each compartment; and on the completion of the work in any compartment, the remaining number of tickets representing the different classes is counted, and thus the number of tickets expended of each class can be ascertained. The men actually held responsible for accuracy in affixing the tickets are the gaugers and estimaters of height, who have on half pay to re-do any part of the work that is found to have been done carelessly.

The Forest Guards are responsible for the quantity of work done; regularity in its execution, and for the custody of the tickets. They remain constantly with their men while they are at work. The forester keeps a journal showing the daily work of his sub-parties, notes the issues and receipts of tickets, and exercises a constant supervision by moving about in the forest, watching the work, taking check girths and heights in the completed portions, and recording the same in his diary. The check by the officer in charge consists in his periodically visiting the work, testing it on lines through each compartment if he suspects inaccuracy, and by his occasionally making a re-survey of a compartment. The system here described has worked well, and the results are believed to be reliable. As the work has only been in progress a short time, it is not yet possible to give the cost per acre or per thousand trees with accuracy.

Appendix C.

Abstract of the outturn of cuttings made in Mohna Block (including fallen wood) during 1875, 1876 *and* 1877.

Number of compartment.	Area of compartment.	Outturn of cuttings.		
		Oak cubic feet stacked.	Fir cubic feet stacked.	Total cubic feet stacked.
	acres.			
1	44			
2	8	11,850	16,080	27,930
3	6			
4	12			
5	2	2,900	8,500	11,400
6	4			
7	5	19,355	50,048	69,403
8	9			
9	32	10,300	39,500	49,800
10	14	6,100	48,900	55,000
15	24	19,650	3,150	22,800
17	50	50,360	52,182	1,02,542
18	12	7,100	4,400	11,500
19	12	55,930	15,620	71,550
23	33	15,485	1,886	17,371
24	11	4,950	550	5,500
25	33	48,250	40,719	88,969
Total ...	311	2,52,230	2,81,535	5,33,765

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